ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVIII. No. 6. NEW YORK, SATURDAY, FEBRUARY 10, 1906. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. L. W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad St., London, E. C., HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single copy, 10 cents. Back numbers, beyond one month, each . . .25

CONTENTS.

EDITORIAL:
Compound Motors 203
Directed Hertzian Waves 204
Accidents on the Elevated 205
The Electrical Nature of Matter and Radioactivity, by Harry C. Jones. 206
The Illuminating Engineering Society 207
Magnetic Wells 207
The Commercial Value of Electrolytically Produced Hypochlorite Solutions 208
20,000-Volt, Single-Phase Electric Locomotive for Sweden 208
Western Electric Company to Increase Stock 208
The Installations of the Vaudoise Motor-Power Company at the Lakes of Joux and Orbe, Switzerland, by Franz Koester 209
Iowa Telephone Association 213
Canadian Society of Civil Engineers Entertained by Ontario Power Company 213
An Interesting Gasoline Electric Car 214
Electrical Mining Notes, by Sydney F. Walker 215
Meeting of the Kansas Independent Telephone Association 216
Chicago Telephone Rates 216
Reception to Dr. Ostwald by the New York Section of the American Electrochemical Society 217
The Award of the Edison Medal for the Year 1906 217
Electricity for Athens Tramways 217
The Proper Handling of Consumers' Meters, by G. A. Barrett 218
Power Plant Economics, by Henry G. Stott 219
Power Production and Coal Resources 224
Portland, Ore., Electrical Notes, by C. M. Hyskell 225
Three-Phase-Single-Phase Transformation—A Correction of a Misapprehension, by Charles F. Scott 226
Long-Distance Wireless Telegraph Message 226
Electric Lighting at the New York Hippodrome 226
A Review of Telephone Patents Issued in 1905 (Concluded), by Edward E. Clement 227
BOOK REVIEWS 229
Motor-Drive and Machine-Shop Economy, by E. R. Douglas 230
The Award of the John Fritz Medal 234
Consolidation of Ohio and Indiana Railway Associations 234
Central Station Advertising 234
Electrical Notes from Europe 235
Electricity on the Erie Lines 237
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 238
METHODS OF GETTING NEW BUSINESS 240
INDUSTRIAL SECTION:
Charging Telephone Batteries 241
The New Home of the Central Electric Company 241
An Important Understanding in the Manufacture of Incandescent Lamps 241
Some Recent Allis-Chalmers Installations 242
The "Paragon" Sewing-Machine Transmitter 243
Blake Compressed Cleats 243
The "Redding" Automatic Time-Switch 243
A New Departure in Trolley Wheels 244
The Crouse-Hinds Company "Condulets" 244
CURRENT ELECTRICAL NEWS 245

In the early days the electrical designer, endeavoring to secure an efficient use of material, ran his machines at high velocities and the tendency was for higher speeds. But very high speeds were not so desirable from the engine-man's viewpoint, and there developed a sharp controversy between the advocates of high-speed and slow-speed engines. Gradually the latter type gained the upper hand, as the size of the electrical machines was increased and designs improved. But the large slow-speed unit did not hold the field long without meeting a rival. The steam turbine finally secured recognition and at once turned the drift of electrical design in the other direction.

COMPOUND MOTORS.

One of the interesting phases of electrical development at the present time is the rapid advance of the compound-wound direct-current motor into broad fields of usefulness. Installations all over the country illustrate a possible discrimination in the choice of motors for different kinds of service, which augurs well for the economical performance of properly selected types. Specially fitted to meet severe conditions, the compound motor occupies middle ground between the straight series and the straight shunt machines and offers characteristics that peculiarly adapt it to service intermediate between variable and constant-speed operation.

By varying the design of the series and shunt windings the compound-motor manufacturers secure a wide range of service performance. If speed regulation is unimportant, a powerful starting torque with a relatively small current can be obtained, and if starting torque is not the essential feature of operation good speed regulation is assured in a design providing for a larger initial current flow than in the preceding case. Comparing the compound motor with the ordinary series machine, we find that with a given change of load the speed does not vary as much with the former, though the compound outfit requires a larger current for a given starting torque and sooner reaches its maximum torque limit. Contrasted with the shunt motor, the speed range for a given change in load and the maximum starting torque are both greater with the compound type, the torque per ampere also being less in the case of the shunt machine. These points were well emphasized in a paper upon electric motors recently prepared by W. Edgar Reed for the Engineers' Society of Western Pennsylvania.

One of the strongest points in favor of the compound motor is its inability to run away in case the load is suddenly removed. The shunt winding limits the maximum speed of the machine running light, while the series winding furnishes a good starting torque under load. The latter feature adapts the compound motor particularly to the driving of pumps in intermittent service, and many automatic pumping plants are now annually equipped with these machines. When the compound motor is installed with a suitably designed flywheel it is possible to use it in driving bending rolls, planers, heavy saws, shapers, punches, shears and the like without incurring inordinate current fluctuations at the time of reversal. Numerous printing presses have been equipped with compound motors and in elevator or traveling-crane service not requiring as great a range of speed control as would occur with series motors, the compound type supplies a long felt want with comparatively moderate fluctuations in power consumption. When lights and motors are to be run upon the same circuits the case of the compound motor, therefore, deserves pretty careful study. Striking a balance between two radically different types of motor, the compound machine partakes of the advantages of each and its usefulness in general practice is certain to increase more and more as time passes.

DIRECTED HERTZIAN WAVES.

As is well known the methods now employed for sending wireless telegraphic signals disperse the electric waves to the four quarters of the globe, so that but a small fraction of the energy sent out from the sending station is useful in producing signals at the receiving station. A practical method by which the waves might be sent out in one direction, or at least through a relatively small angle, would greatly improve the efficiency of transmission, and, other things being equal, would increase the distance to which signals might be sent; but, more important than this, it would avoid much of the interference between neighboring stations which now occurs. When either one of two such stations wishes to send or receive a message it is now necessary for the other station to remain silent.

The desirability of developing a method of directing Hertzian waves has been recognized ever since wireless telegraphy was first shown to have any commercial value, but the difficulties of accomplishing this seemed almost insurmountable. Two inventors have, however, come forward with plans, both of which have been tried experimentally in a limited way. Artom in Italy conducted some experiments which seemed to him to promise partial success, though, unfortunately, no description has yet been published of his system which enables others to judge of its value. The other inventor is Dr. Ferdinand Braun, who obtained encouraging results in a series of experiments conducted at Strasburg. These were described in the ELECTRICAL REVIEW for September 16, 1905.

Since these experiments Dr. Braun has been going on with his research. The work is of extreme difficulty, because the quantities to be measured are so exceedingly small that the energy employed can only be measured by the most delicate apparatus, the time during which it is in evidence is exceedingly short and the frequencies of the oscillations between which a difference in phase must be measured are high, being of the order of several million per second.

The first step necessary was to develop a method of measuring—or, at least, detecting—differences in phase between such oscillations. This he has accomplished by placing in inductive relation to his two oscillating circuits secondary circuits having identical constants and arranged so as to be equivalent in every respect. The secondary coils of these secondary circuits are placed so as to be acted upon inductively by the oscillations in the primary circuits whose difference in phase is to be measured. Then, by connecting the secondary circuits in series, first so that the electromotive forces set up in them will act together and then in opposition, the difference in phase of the primary currents may be detected. Such circuits are easy enough to lay out on paper, but when one attempts to set them up for testing many difficulties are encountered. The secondary circuits first must be made exactly similar in every respect and they must be placed so that neither one is affected more by exterior objects than the other; in fact, great care is necessary even in arranging the reversing switch so as not to upset the balance. Dr. Braun has nevertheless been fairly successful with his arrangement. For detecting difference in phase he can use either a measuring spark-gap or a bolometer of some description; but the most useful instrument is the cathode ray oscillograph, which owes so much for its development to Dr. Braun himself.

Oscillations may be set up in the two primary circuits having the same frequency, but differing in phase in several ways; for example, a set of condensers may be connected together by two parallel circuits having different constants. When the condensers are caused to discharge across the spark-gap oscillations are set up in the two circuits. Since the frequencies of discharge are high—being from one to five million per second—the frequency is determined by the inductance of these circuits, the ohmic resistance having no effect. Ohmic resistance does, however, if it be large, affect the phase of the oscillation, so that by introducing into one of the circuits a resistance much larger than that in the other a difference in phase may be obtained. This method is objectionable because the resistance decreases the energy of the oscillations in that circuit and damps them out rapidly. Another method is to couple two circuits together inductively, the primary circuit setting up oscillations in a secondary. If the secondary circuit be tuned to resonance, the current flowing in it will be in phase with the electromotive force set up in it; and with such a circuit properly arranged with regard to the primary, a considerable amount of the energy set into motion in the primary circuit may be transferred to the secondary. Dr. Braun has in this way transferred thirty per cent of the primary's energy to the secondary, although the mutual inductance of the two circuits was but twelve per cent of the inductance of the primary.

When two circuits are arranged in this way, the electromotive force induced in the secondary circuit is practically in quadrature with the primary current, but the current in the secondary, since this circuit is in resonance, is practically in phase with its electromotive force; hence the primary and secondary currents are nearly in quadrature. This condition can not be realized exactly in practice. The phase difference between the two oscillations varies as the oscillations die out, but since they last for a short time only the effect is practically that of a constant difference in phase.

The experiments with the cathode ray tube showed this action. These tubes make use of the deflecting action of a magnetic field on the cathode ray, the ray forming a massless pointer. The action is made visible by allowing the ray to fall on a phosphorescing screen. Using such a tube, with circuits arranged as described, Dr. Braun obtained figures which resembled a group of ellipses having different ratios between their axes and in which the positions of the axes were shifted. This effect is due to damping, which not only causes the phase to shift, but which changes the relative values of the oscillations in the two circuits. As the oscillation of the primary is damped out that in the secondary increases.

Another method of obtaining phase differences is called by Dr. Braun "linked oscillatory circuits." In this two oscillating circuits containing inductances and capacities are coupled together by two pairs of connections. Two of these connections have low resistance and inductance, and the other two high

resistance or inductance. The latter pair of connections is merely to ensure that the condensers in the two circuits be charged to equal potentials. Having these condensers charged and causing a discharge to take place in one of the oscillatory circuits, this sets up through the secondary circuit, by means of the pair of connections having low inductance and resistance, an oscillation which finally causes the second circuit to discharge through its spark-gap; and by properly proportioning the constants of the two circuits and of the connections—or coupling arcs, as they are called—the discharge in the second circuit can be caused to occur with a given time lag with respect to the first discharge. In this way two oscillations having a given phase difference are obtained. The action of such circuits has also been studied experimentally by means of the cathode ray tube and interesting diagrams have been secured showing that the theory is correct; for example, by connecting in the oscillating circuits two coils arranged to act upon the cathode ray and causing either one of these to act alone, either a horizontal or a vertical line is traced on the phosphorescent screen. Causing the two oscillations to take place together simultaneously, a line inclined at forty-five degrees is obtained. Now, by introducing into the coupling arcs between the two circuits inductance, a series of ellipses is obtained, showing that a difference in phase has been set up.

The work so far done, with the exception of the practical tests referred to above, has been in the laboratory only. The research is one of great difficulty not only on account of the delicacy of adjustment required and the difficulty of making the measurements, but because the analytical study of the phenomena is most complex. We seem to be a long way from the practical application of this system, but, on the other hand, a most encouraging start has been made and progress may take place faster than is anticipated. This is, undoubtedly, one of the most promising directions in which wireless telegraphy can be developed. Possibly it may become the most important.

ACCIDENTS ON THE ELEVATED.

We have been asked whether there is any significance in the fact that during the many years during which the elevated roads in New York and Brooklyn were operated by steam locomotives no car was thrown to the street, yet within a year two such accidents have happened to electrically propelled trains. The facts are rather few to generalize upon, but as the question has been put by an engineer who has made a special study of urban railway operation it deserves consideration.

There is, of course, nothing in the mere fact that electric power is used instead of steam. If there be any reason for the accidents it must be sought either in the way the electric power is applied to the cars, in the method of handling the cars, or in changes in the track structure. The latter possibility may be dismissed at once, since there has been no change in the structure to account for the accidents.

As regards the method of applying the electric power several questions arise. In the first place the propelling mechanism is placed on the car trucks instead of in a locomotive and these motor cars are distributed throughout the train. The tractive action is therefore different, for with the steam locomotive there is a strong tractive effort applied at the front of the train. With the motor-equipped trains the leading car drives itself and assists in drawing the trailer which follows it. The last motor car propels itself and assists in pushing the car ahead of it, should this be a trailer. The motor cars elsewhere throughout the train are propelling themselves and pushing or pulling other cars, as the case may be. There is thus some difference in the action as compared with the steam locomotive, for with a train propelled by steam the tension along the train would tend to draw the cars against the inside rail at curves. There would be no action tending to force them against the outside rail. It is probable, however, that this effect is of little or no importance, because it is customary for the trains to take curves slowly, drifting around them, as it were, so that there should be no tension or compression along the train.

The next difference is in the equipment of the train. With the steam train all the cars are trailers and light. With the electrical train a certain number of cars are equipped with heavy motors; but these motors are placed low down, thus increasing the stability of the cars. The equipment does add to the weight and therefore the inertia of the cars, but the fact that the cars which have been thrown to the street have been trailers would seem to show that no trouble can be attributed to the added weight.

The remaining possibility seems to offer the most probable explanation of the accidents. One of the important gains secured by the electrical equipment is the increased acceleration made possible. With electrical equipment starting from rest, a higher speed is reached in a given distance than with the old steam equipment. When the first accident occurred the motorman expected to run straight ahead, but the switch deflected the train around a curve. It is possible that the motorman did not realize the rate at which his train could be accelerated, and that when it reached the curve it was going at a higher speed than he intended. In the second case the leading car kept the straight track, but for some reason, not fully explained, the second car took the switch and the momentum of the train threw it off the structure. In this case also it is possible that the motorman was going at a speed higher than he realized.

It is probable that in neither of these cases can the blame be laid to the electrical equipment. The accidents might have happened with a steam-drawn train under similar conditions, but the fact that they did happen with electrically propelled trains and the further fact that these trains have a higher rate of acceleration than the old steam trains make it worth while calling attention to this possibility. For these reasons the greatest care should be exercised by the motorman in approaching curves and switches. Because he has been accustomed to starting from a certain point with the throttle of a steam locomotive fully open there is no excuse for his throwing his controller handle all the way around when his electric train stands at the same point.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER XVIII.—(*Continued.*)

ACTINIUM AND ITS DECOMPOSITION PRODUCTS.

Uranium was shown by Crookes to yield uranium X, which could easily be separated from the uranium by chemical means. Similarly, Rutherford and Soddy showed that thorium forms thorium X, which can be separated from thorium by very simple means. It was obvious that similar products would be looked for in the other radioactive substances.

It will be remembered that radium does not yield any substance corresponding to uranium X or thorium X, but forms apparently at once the emanation. Godlewski, working with Rutherford, has found such a product produced from actinium.

To the hydrochloric acid solution of the actinium, ammonia was added. A reddish-brown precipitate was formed, which was probably the hydroxide. The filtrate was evaporated to dryness, and the ammonium salts driven off by ignition, when a small black residue remained, which became white on heating.

This residue was found to be *intensely radioactive* as compared with the actinium from which it was separated. The activity was found to decrease slowly with time, according to an exponential law.

The actinium, from which the intensely radioactive product had been separated, was found at first to be almost non-radioactive. It recovered its radioactivity with time, the recovery curve being the inverse of the decay curve of the residue.

It will be seen that the above results are strictly analogous to those obtained with uranium and thorium. From the analogy to thorium X, the above highly active product was termed actinium X, and written AcX.

The radioactivity of AcX, when first separated from the actinium, was *more than one hundred times* as great as that of the actinium itself. The residue obtained by evaporating the filtrate, as above described, is not all actinium X, but consists chiefly of non-radioactive material, which is probably some of the rare earths.

The analogy between uranium, thorium and actinium is, as we have seen, very striking. There is, however, one marked difference. After thorium X is removed from the thorium there remains in the thorium a residual activity, which amounts to about twenty-five per cent of the total radioactivity possessed by normal thorium.

After actinium X is removed from actinium, the activity of the remaining actinium, when tested immediately, is only about five per cent of what it is in the normal substance.

Godlewski tried to remove this small residual activity by repeatedly precipitating the actinium solution with ammonia. Eight precipitations were made in seven hours. The residual activity, however, still remained. This was probably due to the presence of a small amount of actinium X, which could not be separated from actinium. The latter when freed from actinium X is perfectly non-radioactive. This shows that the production of actinium X from actinium is, as we say, a "rayless change," no radiation of any kind being given off.

Actinium X was shown to give out α, β and γ rays. That the β rays come directly from actinium X, and not from the excited activity resulting from the deposit of the emanation, is made slightly probable by the following facts. The curves of decay of the activity of actinium X, are the same, whether the activity is measured by the α or the β rays. It is also pointed out that the activity of actinium X, measured by the β rays directly after strong heating which would remove all the cause of excited activity, has a large value even at the beginning. This would not be the case if the β rays came from the excited or induced activity.

The problem of the *origin of the emanation* in actinium was then attacked. It will be remembered that the thorium emanation comes from thorium X. Does the actinium emanation come from actinium X? This question can be easily answered.

Remove the emanation from actinium containing actinium X, and test the amount by the activity. Then remove the emanation from an equal amount of actinium from which the actinium X has been separated, and test its activity. The result is very satisfactory.

The actinium from which actinium X has been separated gives practically no emanation. Further, the amount of the emanation increases as the amount of actinium X increases, and decreases at the same rate that the activity or as actinium X decreases.

Godlewski points out that the emanation being present only when actinium X is present, and being always proportional to the amount of actinium X that is present, must be the product of actinium X.

The products of actinium that have thus far been shown to exist, are the following. Actinium yields actinium X, the change being a rayless one. Actinium X gives out α, β and γ rays and yields the actinium emanation. The actinium emanation gives out α particles and produces actinium A. Actinium A yields actinium B, the change being rayless. Actinium B gives out α, β and γ rays, and yields actinium C.

Godlewski also shows that the β rays from actinium differ from the β rays from other radioactive substances. In the first place they are completely homogeneous, and in the second, have less than half the penetrating power of the β rays emitted by other radioactive substances.

He also showed that the γ rays from actinium have only about one-fourth the penetrating power of the γ rays from radium.

EMANIUM.

During the last year or two a number of articles have appeared on a supposedly new radioactive substance called *emanium*. It was discovered in pitchblende by Giesel, and was found to be related chemically to the elements of the cerite group, and especially to lanthanum and cerium.

The dehydrated chloride or bromide shows a discontinuous phosphorescent spectrum of three lines. Glass in which the substance was preserved for some months was colored violet. Paper was browned and decomposed. After the maximum activity was reached the activity of the solid substance underwent no further change. Giesel concluded in his earlier work that this substance is a new radioactive element. He thought that the results could not be accounted for as due to any induced activity resulting from contact with radium. When a current of air was blown over the preparation of the supposedly new substance and then against a phosphorescent screen, bright scintillations or sparks made their appearance, which were more distinct and larger than in the case of radium, and the effect was more striking than in the ordinary spinthariscope.

This strongly radioactive substance, supposed by Giesel to be a new radioactive element, was named by him *emanium*.

He, however, pointed out about a year ago that it was possible that emanium was identical with the actinium discovered by Debierne. At that time, however, there was not sufficient known about the properties of the two substances to determine whether they were identical or not.

Debierne undertook a comparative study of actinium and emanium, and concluded that the two were identical. Giesel, however, points out that there are certain

differences in the properties of the two substances that need explanation before we can regard the two as identical. The activity of the emanium induced radioactivity falls to half value in 34.4 minutes, while that of actinium requires 40 minutes to decay to half-value.

He also shows that the three lines observed in the phosphorescent spectrum of emanium, having the wave-lengths 4885.4, 5860 and 5909, respectively, had not at that time been observed in actinium. Further, since these lines could not be identified with those of any known element, it seemed fair to conclude that they were due to a new element.

Giesel studied the activity of emanium and showed that the emanation was not driven out by heating or solution as with radium, and concluded that there was a solid, non-volatile substance formed.

Subsequent work, however, has shown that the three lines mentioned above are really not new lines at all, which can be referred to a new element, but were produced by one of the didymia that was present. This invalidates one of the lines of reasoning which led Giesel to conclude that he was dealing with a new substance. He separated the active constituent or constituents from emanium in a manner analogous to that employed by Rutherford in the case of thorium. He found most of the activity of the emanium in the small residue which remained when the solutions containing emanium were precipitated with ammonia. On account of the analogy with thorium X Giesel termed this active residue *emanium* X.

He showed further that when emanium X has been separated from emanium, more emanium X is *continually being formed.* This again is strictly analogous to the condition of things in thorium. It was also established that most of the activity of emanium is due to the emanium X that is present in it.

The question as to the identity of emanium and actinium was taken up quite recently by Hahn and Sackur. It will be recalled that the argument advanced by Giesel based upon spectrum analysis, in favor of the two substances being different, has been shown to be untenable—the lines supposed by him to be produced by emanium being really those of one of the didymia.

The second argument advanced by Giesel to show that these two substances are different was based upon the different amounts of time required for the induced radioactivities produced by the two substances to decay to half their initial value. These measurements have been repeated by Hahn and Sackur, with the result that the amounts of time required in the two cases *are the same.*

These authors have also determined the amount of time required for the emanation itself from the two substances to decay to half-value. They find that the time in the two cases is *exactly the same,* to within the limits of experimental error.

From these facts they conclude that the *actinium of Debierne and the emanium of Giesel are probably identical.*

New light seems to have been thrown on the relation between actinium and emanium by Marckwald. He thinks that he has satisfactorily solved the problem. The rare earths obtained from the radium mother-liquor were transformed into chlorides, and the thorium precipitated by thiosulphate. This thorium showed strong emanating power and contained the actinium of Debierne. From the solution cerium was first precipitated, and then the didymia and lanthanum as oxalates, which were transformed into oxides. Neither the cerium nor the mixture of the didymia and lanthanum showed any considerable emanating power.

The thorium was then purified by subjecting it to a number of processes, but the emanating substance clung to the thorium in all of these operations.

The activity of this actinium which accompanied the thorium was studied for several months and *was found to decrease.* The mixture of the didymia and lanthanum, on the contrary, *acquired greater and greater emanating power with time*—their emanating power increasing in the same ratio as that of the actinium in the thorium decreased. The author points out that this is analogous to the case of thorium and thorium X.

The explanation of these facts seems very simple. The radioactive substance that accompanies the lanthanum gives off no emanation. It, however, decomposes into a second substance, which in its chemical reactions resembles thorium. When the latter substance undergoes further decomposition a strong emanation results.

To test the correctness of this interpretation the following experiment was performed: A half-gram of pure thorium oxide was added to eighteen grams of the didymia-lanthanum mixture, which had stood until it emanated strongly. The whole was then dissolved in hydrochloric acid and the thorium again precipitated by thiosulphate. The thorium precipitated now contained nearly all the emanating power, the solution of the didymia-lanthanum mixture contained very little of the emanation.

The conclusion seems necessary that there is something in the didymia-lanthanum mixture *which yields a substance* closely allied chemically to thorium and which has strong emanating power.

Emanium and actinium are, then, not identical. Emanium undergoes decomposition and yields actinium—*emanium is the parent of actinium.*

As Marckwald points out, it is unfortunate that Giesel should have chosen the name emanium for the substance that accompanies the didymia-lanthanum mixture, since this substance has no emanating power whatsoever.

This is after all a minor matter. The important point is that the relation between emanium and actinium seems at last to have been cleared up.

(To be concluded.)

The Illuminating Engineering Society.

The Illuminating Engineering Society will hold its regular monthly meeting on Tuesday evening, February 13, at the Hotel Astor, New York city. The programme for the evening consists in an inaugural address by the president, L. B. Marks, which will outline the general scope and policy of the society, and a discussion of topics by those present. The meeting will be called to order at 8 o'clock.

Magnetic Wells.

The term "magnetic wells" has been applied to wells whose casings attract and hold iron objects. In the study of underground waters much interesting information concerning these magnetic wells has been obtained by members of the United States Geological Survey. A report is now in preparation in which some of the magnetic features of these wells are described and the causes of these phenomena discussed, and the officers of the Survey would be pleased to receive additional data on the subject from drillers, well owners and others who have knowledge of wells of this character. Usually only small objects, such as nails, are attracted by the casings, but occasionally a well is found in which the magnetism is sufficient to hold hammers or wrenches. Information is especially desired concerning the size of objects attracted by the casings, the method used in sinking the well, the nature of the materials penetrated and the length of the casing.

The Commercial Value of Electrolytically Produced Hypochlorite Solutions.

Broadly speaking, electrolytically produced hypochlorites of soda, magnesia and calcium have two main uses—as disinfecting agents or germicides, and as bleaching agents. The methods of producing them and their value for these purposes have been discussed by Mr. W. P. Digby. Although the matter was first taken up somewhat energetically early in the nineties the results seem not to have been altogether encouraging, and interest lagged. Recently the matter has been brought forward again, due probably to the installation of a new system in an English town. From a sanitary point of view such solutions have certain advantages: they act rapidly, are easy to apply, are not poisonous and the plant does not require skilled supervision; raw material is plentiful and cheap, and the electric power required can be obtained inexpensively at almost any town. The difficulties which have been met are the cost of the electrolyzers, particularly when their anodes are platinum, the difficulties which arise with certain types of apparatus when a stable solution is desired, the low electrochemical efficiency and a low yield of available chlorine. Further, the wear and tear of the anodes is considerable. There are, in addition, other difficulties not due to the apparatus itself. It has been attempted not merely to sterilize but to oxidize the organic constituents of crude sewage or exceedingly impure effluents. It is easily possible to disinfect either of these and to render the latter sterile, but the complete oxidation of organic matter by hypochlorite solutions is commercially impossible. Another difficulty limits the application of hypochlorite solutions as sterilizing media, pure and simple, because the commission for preserving the purity of the Thames has laid down stringent standards as to the amounts of organic substances which constitute pollution in any effluent, but it does not lay down any standard in regard to its bacteriological condition. Chemically, the analyst should be satisfied as to the purity of the effluent, a state of affairs which septic banks or bacteria beds or other similar devices are well competent to provide, in that they allow the bacteria to destroy the organic matter. Bacteriologically, the pathologist should be satisfied with the wiping out of the bacteria when they have performed the reasonable service demanded of them by the chemist. Their destruction at this stage would remove a potential source of danger. The problems which accompany the manufacture of such solutions have not been much discussed. But little is known by the public concerning the cost of such plants per kilowatt of normal capacity. Where platinum is used, the thickness of the foil varies considerably. The author prefers a foil about 0.004 of an inch in thickness. He has been successful with a foil only 0.003 inch thick, which weighed fourteen ounces troy per kilowatt of normal load. Graphite has been used to some extent, but it is subject to disintegration. As yet the cost of renewals is not known, so that a comparison can not be made with platinum. When the hypochlorite solution is carefully prepared it is fairly stable. Solutions of this kind when bottled in dark-colored glass lose only about two and one-half per cent of their available chlorine per year; but, on a working scale, a depreciation of two or three per cent per day is not objectionable. The author urges that the performance of electrolyzers should be given in percentages of the theoretical efficiency per kilowatt-hour and not per ampere-hour. The important feature in regard to the treatment of sewage effluents is that at the economical working strength a large quantity of unconverted sodium chloride is wasted. Only about seventeen per cent of the chlorine initially present is capable of doing effective work. At the cheapest working point, where the strength of the electrolyte is six grammes of the chlorine per litre, only about ten per cent of the chlorine present is converted into hypochlorite.—*Engineering Review* (*London*), *January.*

20,000-Volt, Single-Phase Electric Locomotive for Sweden.

A brief description of a 20,000-volt, single-phase electric locomotive supplied by the Siemens-Schuckert Company to the government of Sweden for tests on the Tomteboda-Värtan line is given in the *Electrician* (London) for January 5. This locomotive weighs thirty-six tons and is intended primarily for hauling freight at speeds up to forty miles per hour. The locomotive has three driving axles, the distances between centres being five and one-half feet and seven and one-half feet, respectively. The wheels are forty-three inches in diameter. The frame of the locomotive is built up of side plates braced by cross-stays and end-plates. It is supported on the axles by equalizing levers and flat springs.

Each axle is driven through a one-to-five gear by a 110-horse-power, twenty-five-cycle, 320-volt, compensated single-phase series motor, such as that used on the Murnau-Oberammergau line. The three motors together are able to exert a maximum drawbar pull of 13,300 pounds. The cab of the locomotive is of sheet metal, twenty-one feet long, eight and one-half feet wide and eleven and one-half feet high. It is divided into three sections. The engineer's cabin is at one end and is entered by side doors. Behind it is a compartment four feet high, containing the transformers and controlling gear and two auxiliary motors. Over the latter compartment is another narrower compartment for the high-tension cables. Two collectors of the bow-type are provided. These are of aluminum and are pressed against the collecting wire by springs.

The transformer is of the oil type, with a normal rating of 300 kilowatts. It is provided with taps on the primary, enabling it to be used for voltages of from 5,000 to 20,000. The secondary winding can also be tapped at a number of points, so that the voltage supplied by the motors may be varied from 160 to 320. Current at 120 and 240 volts is supplied for lighting and heating and for driving the auxiliary motors.

The controller has ten main positions. In the first position, for low speed, a resistance is connected in series with the motors. It is provided with blowout magnets, and provision has been made for cooling the motors by a blast of air. For this purpose a fan has been provided, capable of delivering 1,400 cubic feet of air per minute at a pressure of three inches of water. It requires 1.8 horsepower and is supplied by a seven-horsepower motor, which also drives other machinery. This cooling air is drawn in through the upper compartment and passes through dust sieves and is then fed to the interior of the motors through iron tubes with flexible leather joints. The transformer oil is cooled by circulating it through pipes, the power for this purpose being supplied by the same motor. The locomotive is equipped with a vacuum brake actuated by a vacuum pump driven by a motor.

Western Electric Company to Increase Stock.

The gross earnings of the Western Electric Company, of Chicago, for 1905 were $44,146,000, an increase of thirty-six per cent. The stockholders have voted to increase the capital stock to $25,000,000, and $3,000,000 of treasury stock will be issued immediately. Stockholders may subscribe in the proportion of twenty-five per cent of their holdings. The company's sales now average $4,500,000 monthly.

The Installations of the Vaudoise Motor Power Company at the Lakes of Joux and Orbe, Switzerland.

By Franz Koester.

THE valley of Joux is situated among the Jura mountains at an altitude of about 1,000 metres above the sea level and forms a natural closed basin with a superficial area of about 211 square kilometres. The valley contains two lakes of unequal size, the lake of Joux and the lake of Brenets, the principal feeder to these lakes being the Orbe.

For regulation an artificial canal, which may be drained at will, provides for carrying off sufficient water to prevent the flooding of the valley and to maintain the level of the lakes at fixed limits. Many projects with various conditions have been exploited in recent years, the work herein described being due to a study made by Mr. Jordan Martin, chief of the department of public works of the canton of Vaud, and under the direction of Mr. A. Palaz as engineer. The study of the variation in the level of the lakes during the last fifteen years has shown a maximum rise of 1.08 metre in the course of ten days, and, considering this as a maximum, it was necessary in order to avoid a flood to provide a canal capable of carrying off a quantity of water corresponding to this rise, and the surface of the lake being in the neighborhood of 10,000,000 square metres, provision had to be made for a canal capable of carrying off twenty-one cubic metres per second. The artificial canal is fed from a dam by means of regulating valves, the dam being situated at the northern end of the Brenets lake. The canal is completely underground and its total length from the dam to the place of distribution is 2,632 metres, and throughout its length it is built with a uniform grade of three per cent; the mean cross-section is about 5.7 square metres, the canal being 2.2 metres wide by 2.6 metres high. The tunnel ends in a collecting chamber, of which two sides form a weir thirteen metres long, through which the water flows slowly into an eccentric basin, from whence lead the two discharge conduits. In addition, the first basin opens at the side into a rectangular chamber, from whence the water for power purposes flows into the pressure conduits, the flow being regulated by a valve. The entire installation is built in such a way as to throttle the flow to the pressure conduits and allow of an easy flow to the discharge conduits. The installation provides for three pressure conduits, one of which is at present in place. The mounting of these conduits is shown in Fig. 1. The discharge conduits alone can take care of the flow of twenty cubic metres per second and thus assure the regulation of the water level in the lakes independent of the industrial enterprise. Two conduits have been installed, each 722 metres long, from the entrance chamber to the point of reentry into the Orbe, the static fall between these two points being 237 metres. The interior diameter of the conduits is 8.5 centimetres, except for the first 100 metres of length where the cross-section is conical and has a diameter of 1.4 metre at the water chamber, these dimensions providing for a flow of ten cubic metres per conduit. The tubes are built of steel nine millimetres thick, which assures sufficient resistance to take care of shocks and dynamic effects.

Each conduit is controlled at the water chamber by a special mechanical valve, which permits of opening gradually to the flow of the discharge water. The conduits are set upon heavy masonry or concrete foundations and have intermediate supports of cast iron. Two expansion joints have been placed in each conduit and are furnished with manholes and relief valves.

The power available is limited by the capacity of the reservoir formed by the lakes, the total fall being 236 metres and

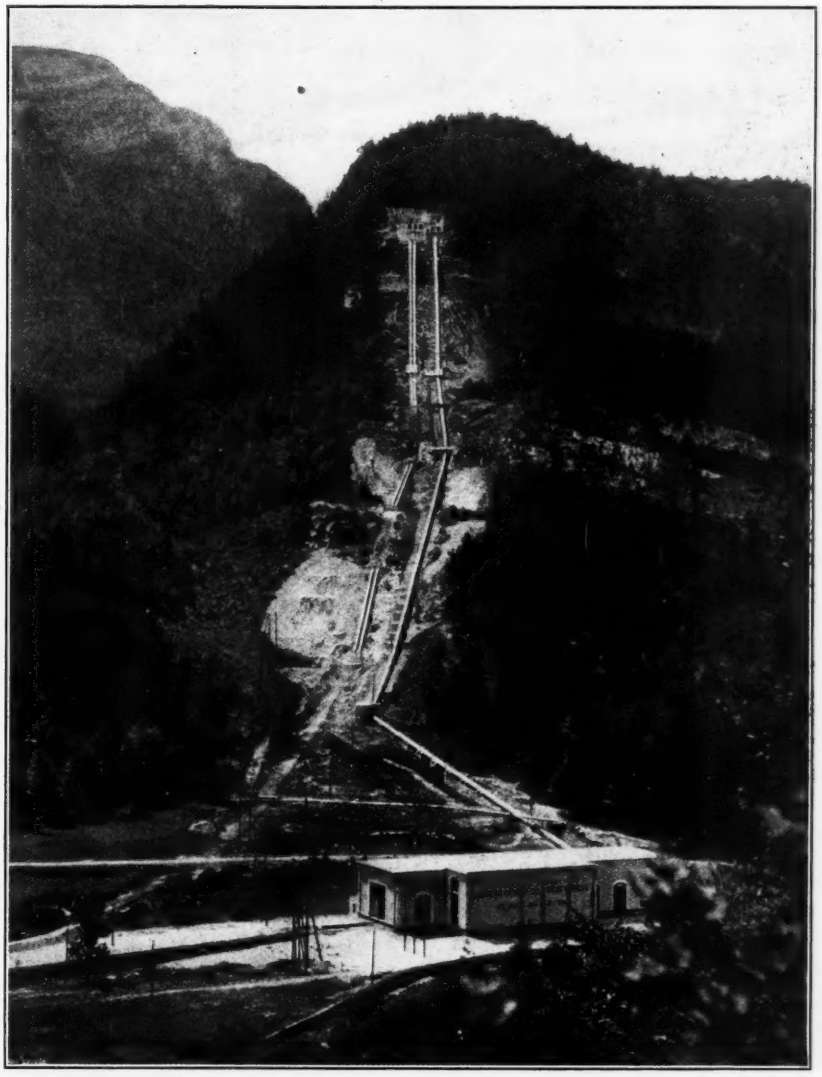


FIG. 1.—POWER PLANT AND PENSTOCKS, VAUDOISE MOTOR POWER COMPANY.

the net fall 234 metres. With a turbine efficiency of seventy-five per cent and a flow of 430 litres per second, an output of 1,000 horse-power is obtained, which means an available source of 6,740 horse-power at high water and 3,720 horse-power at a mean water level. These figures, however, apply to an operation extending over twenty-four hours per day and permit of a momentary consumption of energy much greater than the figures show. Like all central stations where lighting represents an important part of the consumption of energy, the station at La Dernier produces each day, and particularly at certain seasons of the year, a maximum amount of energy for lighting, during the rest of the day the curve of energy consumption being extremely variable on account of the daily operation of motors.

The variations in the output during the day will be more or less great, according to the importance of electric traction in the distribution system. With a power-house similar to that at La Dernier, where it is necessary to economize in water, it is of great advantage to make the variation in output as regularly as possible, thus permitting the gradual regulation of the flow in the tunnel and making it conform as nearly as possible to the power consumption. Recourse is then naturally had to storage batteries for electric traction purposes. Basing upon the results furnished by similar stations, the ratio between the mean and the maximum daily consumption will be in the neighborhood of 1 to 2.6, and with mean powers of 6,740 and 3,720 horse-power for twenty-four hours it will be permissible to figure on maximum consumptions of 7,520 or 9,670 horse-power at the turbine shafts for momentary outputs. The power-house is designed for an ultimate capacity of 10,000 horse-power, the first installation consisting of 5,000 horse-power in five groups of 1,000 horse-power each. The power-house is located on the right bank of the Orbe and is surrounded by a spacious terrace and is reached at the other side of the river by a steel bridge, the general arrangement being well shown in Fig. 1, the interior view being given in Fig. 2.

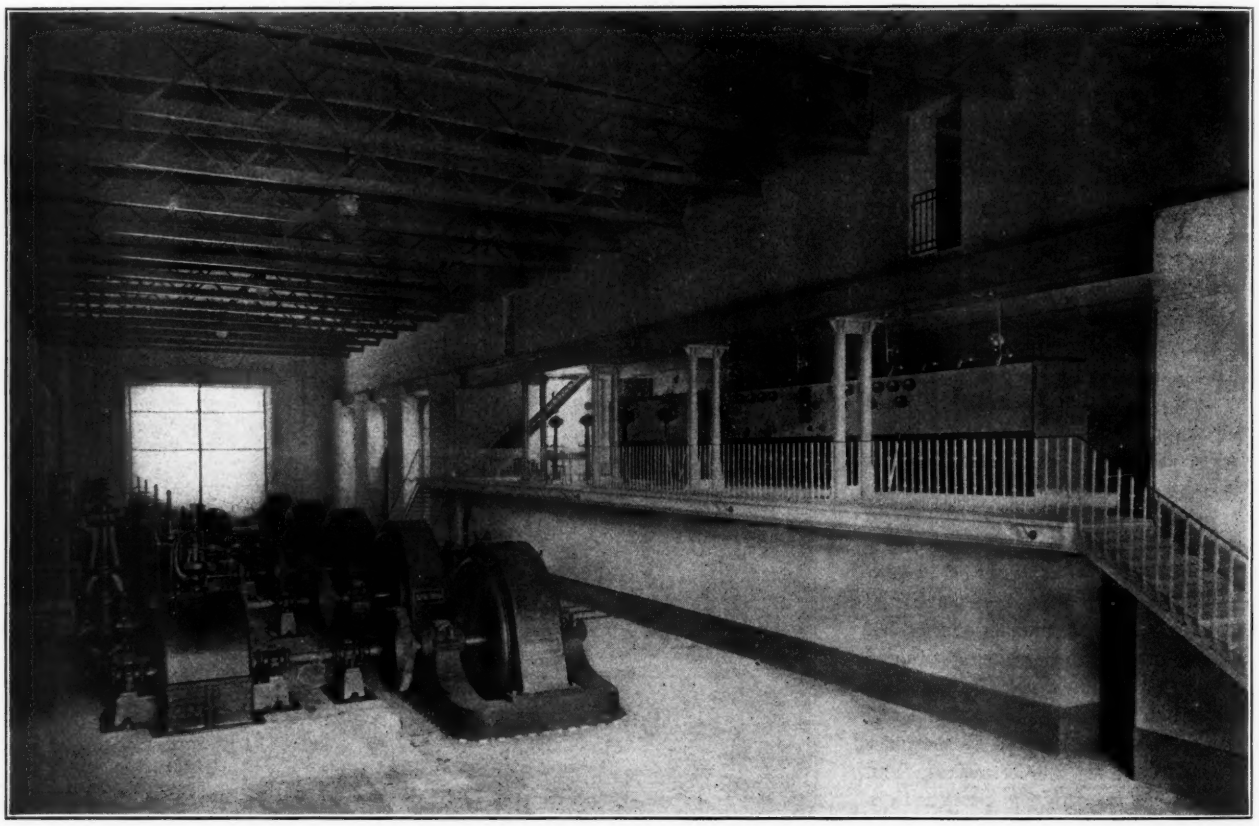


FIG. 2.—INTERIOR OF POWER PLANT, VAUDOISE MOTOR POWER COMPANY.

The building consists of a machine room fifty-five metres long, 12.5 metres wide and ten metres high, and is furnished with a twelve-ton traveling crane. The machine room allows for the installation of three exciter groups at one end and eight generator groups, two additional generator groups being provided for by an enlargement of the building. All the installation relative to the switchboard and controlling apparatus is located in an annex to the main room, the annex being 25.4 metres long, 7.4 metres wide and thirteen metres high. It is divided into four parts vertically: the basement, the ground floor and two stories.

The present installation comprises seven turbines, five of 1,000 horse-power each, with horizontal shaft revolving at a speed of 375 revolutions per minute and operating with a head of 234 metres. They are directly coupled to alternators of the same power. In addition there are two turbines of 150 horse-power each, with horizontal shaft revolving at a speed of 750 revolutions per minute and operating the exciters. The turbines and the piping in the power-house were furnished by the Escher-Wyss Company, of Zurich, and are of the Pelton type, with partial injection, which system is particularly suitable for high pressure. The small turbines have two bearings and the large ones three. All the turbines are furnished with automatic hydraulic governors of the Escher-Wyss type and a pressure regulator.

This pressure regulator is an automatic arrangement which operates so that, as the distributor orifice closes, an orifice of escape is opened in exactly the same proportion, so that the quantity of water cut off by the distributor passes through the

other orifice, the speed of the water in the conduit thus remaining absolutely constant and avoiding any shock. In order

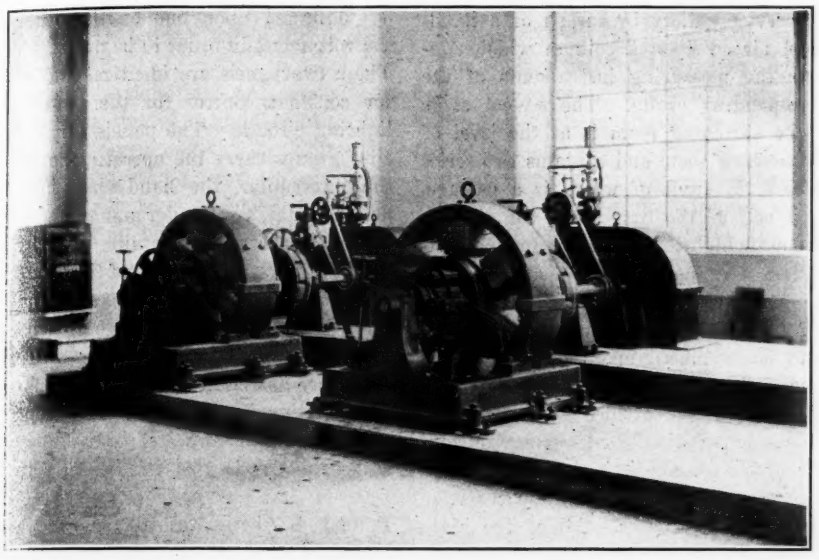


FIG. 3.—EXCITER UNITS.

to prevent the continual escape of the water which would at times mean a considerable loss of energy, the apparatus automatically closes slowly without raising the pressure. The guaranteed efficiencies given by the builders of both the large and small turbines are as follows: 78 per cent at full load, 76 per cent at three-quarters load, 74 per cent at half load. The tests made upon a complete group have shown that these guarantees are obtained and even surpassed as the efficiency of the large turbine at full load was found to be eighty per cent. The speed guarantees are as follows: one per cent under normal conditions, four per cent for a twenty-five per cent variation in load and thirteen and one-half per cent when the turbine is thrown suddenly from full load to no load. Tests have shown that in throwing a turbine rapidly from full load to no load, due to the operation of the circuit-breakers, that the increase in speed was but 7.2 per cent.

The five generators were built by the Oerlikon works and produce, at a speed of 375 revolutions per minute, current at a tension of 1,350 volts with a frequency of fifty periods per second. These machines are calculated to absorb 1,000 horse-power and produce three-phase current with a power-factor $\cos \varphi = 0.75$ and single-phase current with $\cos \varphi = 1$. The alternators are of the fixed inductor type with movable poles.

The bobbins of the inductor are enclosed in micanite tubes and may be removed and replaced in a period of thirty minutes. The armature coils are held between two steel plates and form a rigid body. In spite of the high speed of the inductor the electromotive force-curve of the generators is almost an exact sinusoid. These five generators have given entire satisfaction for more than a year and two new groups of the same type designed for 1,600 horse-

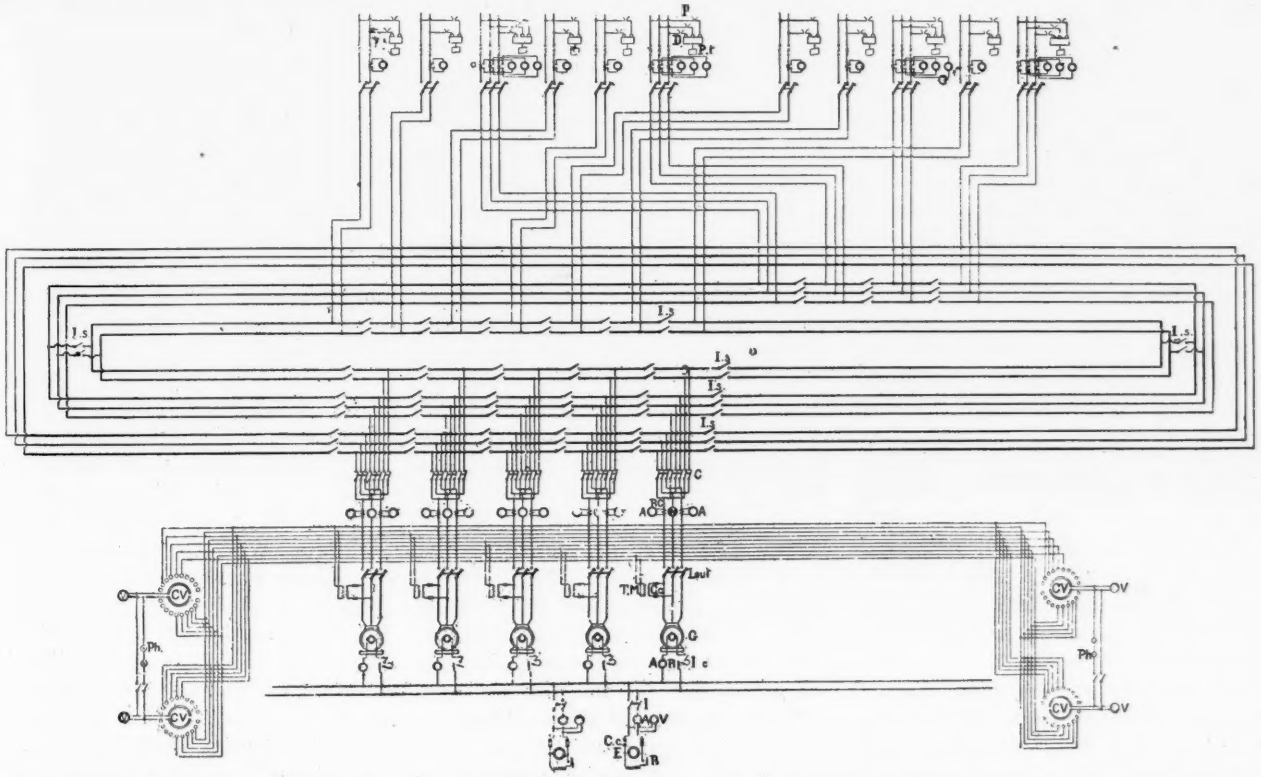


FIG. 4.—WIRING SYSTEM. A—AMPERE METER. C - GENERATOR SWITCHES. CC—CUTOUTS. CV—VOLTMETER SWITCH. D—HYDRAULIC LIGHTNING DISCHARGERS. E—EXCITERS. G—ALTERNATING-CURRENT GENERATORS. I—EXCITER SWITCHES. I.AUT—AUTOMATIC GENERATOR CIRCUIT-BREAKERS. IC—EXCITER CIRCUIT-BREAKERS. IS—BUS-BAR SECTION SWITCHES. P—LIGHTNING ARRESTERS. PT—GROUND PLATE. PH—PHASE LAMPS. R—EXCITER FIELD RHEOSTATS. RC—CURRENT TRANSFORMERS. TM—INSTRUMENT TRANSFORMERS. V—VOLTMETER. W—WATTMETER.

power at a speed of 375 revolutions per minute have recently been ordered.

The exciter groups are shown in the accompanying illustration, Fig. 3. The two dynamos, directly coupled to turbines of 150 horse-power, are of the Oerlikon type, with eight poles, and develop, at a speed of 750 revolutions per minute, 800 amperes at a tension of ninety volts. The efficiency of these machines is 72 per cent at full load.

The switchboard and the accompanying apparatus was installed by the Oerlikon works and comprises all the required features for an up-to-date central station. In order to render visible the operation of the switches, the local service is managed from a gallery at a level above that of the generator room. The apparatus and instruments are placed in such a way that the attendants can see the entire machine room during the switching operation and can also observe the instruments from the machine room floor. The safety of the installation and of the attendants is provided for by a rigorous separation of all the high-tension apparatus and conductors, and to this end the switching room has been built with reenforced concrete partitions at different levels, thus rendering each level a fireproof chamber. The various switches placed upon the generator and feeder circuits are capable of being operated under full load without destructive arcs. They are of the piston type without oil.

The apparatus is grouped at four levels, the two lower levels being divided by longitudinal partitions, permitting of rapid inspection of the different cells. The northern part of the lower level is occupied by the bus-bars, which are of the ring system with section switches, as indicated in the diagram, Fig. 4.

There are three bus-bar rings, one for the single-phase current feeding the lighting lines, a second for the three-phase power lines and a third as a reserve. The section switches permit of throwing out of circuit a group of apparatus belonging to a machine or feeder without affecting any other part of the installation. The arrangement adopted permits of feeding the single-phase bus-bars either directly from the generators or from the three-phase bars. A division of the lower level contains the measuring transformers and these instruments are grouped in cells, the switches of the same groups occupying a corresponding cell in the level above. The control of the measuring transformers and the replacement of fuses is facilitated by a longitudinal service passage. The cables connecting the alternators and the exciters to the switchboard are placed in a larger parallel passage and permit of easy access and inspection.

The machine switches are operated from the service gallery by means of a hand-wheel placed upon a column which supports the measuring instruments of the corresponding group. The second stage of the switching room is at the level of the machine room and contains two series of cells, in front of which is a passage. Each cell of the first series contains an automatic high-tension switch for the feeder lines and the current transformers for the ammeters. The operation of these switches is effected by means of vertical hand levers placed upon the switchboard panel at the third level. The cells of the second series are divided horizontally by a concrete partition, the lower section containing the automatic high-tension switch for the generator and the upper section the current regulator. All of the high-tension switches are of the piston type with porcelain insulation, the automatic operation being independent of the manual control. The automatic interruption of the current at a given maximum intensity is effected by means of an electromagnet, which at the same time breaks the connection between the automatic apparatus and the hand lever. The switch opens and the hand lever executes an independent movement which notifies the attendant of the operation of the apparatus. These automatic switches are equipped with time relays in order to avoid their operation prior to the operation to the interruptors on the line. The third stage forms the service gallery, which overlooks the machine room. The marble switchboard divides this gallery into two parts, the one overlooking the machine room being for local service, and here are placed the columns which carry the instruments for the generators. Each column carries the following apparatus: an ammeter for the exciter current, two ammeters and a wattmeter connected upon the three phases of the alternating current. They carry on the left the operating wheel of the switch, which allows for throwing the alternator upon one of the three systems of bus-bars and at the right the lever for the automatic interrupter for the machine. In front of the column are two concentric hand wheels, the interior operating the exciter switch and the exterior operating the exciter rheostat. The switchboard consists of twenty-two panels, eleven of which are for feeder service and contain the following apparatus: the operating lever of the switch, an ammeter for the lighting circuits and three ammeters for the power circuits. The two panels for the general instruments contain two voltmeters, two-phase lamps and two voltmeter switches, by the aid of which each generator may be connected upon one or the other of the voltmeters in order to be put in phase. These two panels are identical and allow for constant control for the power and lighting circuits. The panels for the exciter groups carry the operating lever for the interrupter, the hand-wheel for the field rheostat, a voltmeter and an ammeter.

The upper stage contains a series of lightning arresters (Fig. 5) of the cone type with water resistances, and are connected immediately after the introduction of the lines into the building. The hydraulic resistance has been completed by a permanent earth-connection, which is kept up by a circulation of water. On the upper stage are also located the lighting transformers for the power-house, which is lighted by both arc and incandescent lamps.

The distribution system of this company is not limited by the capacity of the station herein described, as the company also owns a second power-site on the same river, and the work of construction on power-house No. 2 will be finished in 1906. This plant will be started with four turbo-generator groups of 2,000 horse-power each. The electric energy is distributed both as single-phase and three-phase current throughout a very extensive region at a tension of 13,500 volts. The most prominent characteristic of the system lies in its remarkable diffusion as it serves at present, with the aid of 235 transformer stations, 212 Swiss communes with a population in a neighborhood of 92,000 people.

At the junction points of the principal lines section poles have been erected which allow of the various circuits. The ring-system of the primary network, in connection with these junction poles, permits of feeding a centre by two lines and adds to the continuity of the service. The two power plants may be operated in parallel for feeding the entire network, being connected between themselves by two distinct lines; in case of the shut-down of one plant the other plant may be used to run the entire system. The most distant point which is fed from the power-house requires a line sixty-seven kilometres long. The primary tension of 13,500 volts was chosen after an exhaustive study of the conditions to be met, and the relatively small distances between the power-house and the feeding points and the great number of transformer stations. The principal advantage

of this tension, which is produced directly by the generators, is the possibility of an immediate distribution to the centres of consumption with the aid of a single transformation, and in addition permits the use of transformers with natural ventilation.

The high-tension lines are carried on wooden poles treated with a solution of sulphate of copper and the insulators are of a triple-petticoat type and are subjected as a test to a tension of 80,000 volts for the period of an hour. The line conductors are spaced sixty centimetres apart, each conductor forming the apex of an equilateral triangle. The main lines are constructed of copper wire, from seven to eight millimetres in diameter and the

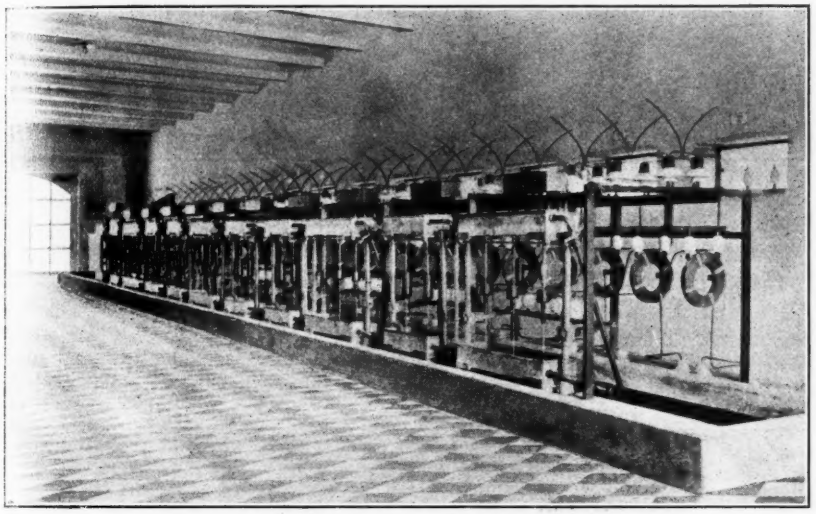


FIG. 5.—ARRANGEMENT OF LIGHTNING ARRESTERS.

branch lines of bronze wire three millimetres, or copper four millimetres in diameter.

The switching stations are built of reenforced concrete and contain a basement and two stages; they are three metres square and 8.7 metres high. The circuit-breakers of the incoming lines are in the lower part; the first stage contains the circuit-breakers on the outgoing lines and a one-kilowatt transformer for lighting the station; the second stage contains the cone-lightning arresters, with water resistances. The transformer stations are of two types: one for single-phase and one for polyphase distribution. They are built by reenforced concrete, there being 171 for single-phase and fifty-two for polyphase distribution. The transformers occupy the lower part and one stage. In the upper part there are four openings, one for each face; one opening for the incoming primaries and the other for the outgoing secondaries. All the apparatus is placed in the lower part, which is provided with two doors, one giving access to the primary circuits and the other to the secondary switchboard; above are the transformers and the primary lightning arresters.

The equipment of the transformer stations has required a great number of single-phase and polyphase transformers, all of which were furnished by the Oerlikon company. Those feeding the lighting and small motor circuits, transform from 12,000 to 250 volts, the secondary winding being arranged so that the tension may be varied from 230 to 260 volts. The single-phase transformers are in three sizes: ten, twenty and fifty kilowatts. The power circuits are fed by polyphase transformers of twenty and fifty kilowatts at a secondary tension of 400 volts. The lighting distribution is the three-wire system, with 250 volts between the outside lines, the conductors being calculated for a maximum drop of four per cent. Incandescent lamps constitute the greater part of the lighting load, the arc lamps being few in number. The electric motors are built for single-phase current of 250 volts, or three-phase current of 400 volts, according to their size and use. The entire electrical equipment of the plant and transformer stations were designed and constructed by the Oerlikon company, Switzerland.

Iowa Telephone Association.

The next annual meeting of the Iowa Telephone Association will be held at the Chamberlain Hotel, Des Moines, March 13, 14 and 15. The programme will be announced later by the secretary, Charles C. Deering, Boone.

Canadian Society of Civil Engineers Entertained by Ontario Power Company.

The Canadian Society of Civil Engineers held its annual convention at Toronto last week. On January 31 the Ontario Power Company had as its guests at its power plant at Niagara Falls the society and the commissioners of Queen Victoria park, along with a number of other invited guests. Covers were laid for 225, but fully a score more sat down. The Ontario Power Company has recently installed a very large electric kitchen. The apparatus can prepare a dinner for 300, and the consumption is said to be about forty horse-power.

The banquet hall was located in the distributing station on the bluff back of Queen Victoria park overlooking the falls of Niagara, and was beautifully decorated. At the chief table were General Francis V. Greene, general manager of the Ontario Power Company; Queen Victoria Park Commissioners Langmuir, Jaffray, Wilkes and Raymond; Superintendent Wilson, of the Queen Victoria park; Mr. H. D. Lumsden, the newly elected president of the Canadian Society of Civil Engineers; Mr. Ernest Marceau, the retiring president of the society; L. L. and P. N. Nunn, chief engineers of the Ontario Power Company; Professor C. H. McLeod, secretary of the Canadian society; E. B. Green, of Green & Wicks, architects, Buffalo; C. H. Rust, city engineer of Toronto and chairman of the entertainment committee, and Messrs. Ryerson, Groves, Converse, Baum, Suhr and Paine, of the Ontario Power Company's staff.

There was no formal list of responses, but several of the officials and guests made brief addresses.

The engineers arrived at Niagara Falls, Ontario, at 11.10 o'clock on a special train over the Grand Trunk Railroad. They were met at the station by officers of the three power companies and escorted first to the generating station of the Ontario Power Company below the falls, the trip being made in special trolley cars provided by the International Railway Company. After a brief inspection of this portion of the plant the guests repaired to the distributing station, where the dinner was served. After dinner the inspection of the power plants was continued, the visitors being conducted to the power-houses of the Canadian Niagara Power Company and the Toronto & Niagara Power Company. The departure for Toronto was made at 3.45 o'clock.

An Interesting Gasoline Electric Car.

In sparsely settled districts where the cost of operating a steam-drawn train is excessive and the immediate investment of capital for an electric service unwarranted, there has arisen a need for a self-contained car which shall be independent of a feeder system and at the same time be cheaper to operate than the ordinary locomotive and train. For this purpose the General Electric Company, in conjunction with the American Locomotive Works, at Schenectady, N. Y., has recently completed a gasoline electric car which presents many features of interest as a proposed solution for this go-between.

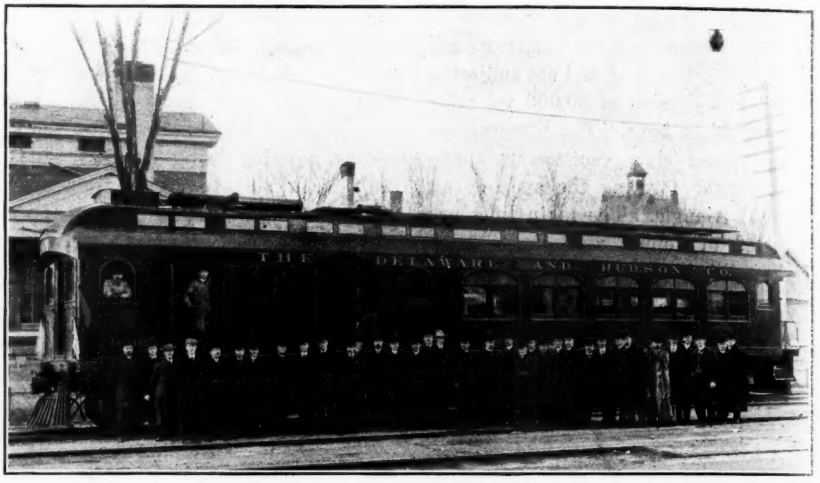
The first trial run of this novel car took place February 3, when a successful trip was made from Schenectady to Saratoga, N. Y., and return over the lines of the Delaware & Hudson Railroad. During the trip several important features of this method of driving were demonstrated. While the car was not designed for high speed, the average running time was about thirty-five miles an hour and several times the car attained a speed of over forty miles an hour. The smooth and rapid acceleration was most favorably commented upon by the engineers present as well as the complete absence of vibration which might be thought to accompany the use of a gasoline engine.

This car consists essentially of a gasoline-driven electric generator furnishing current to electric motors geared to the driving wheels and controlled by a method similar to that employed in the ordinary electric car equipment. The car in question, shown in the illustration, is of the combination type, comprising a passenger compartment, smoking room, a baggage room, engine room, one toilet and a motorman's compartment. The car is sixty-five feet long over buffers and equipped weighs sixty-five tons. A complete controlling equipment is located at each end of the car, one controller being located in the engine room and a similar controller in a compartment at the other end. The car has seating capacity for forty passengers, including seats for twelve in the smoking room. In general it is built on the lines of a standard Delaware & Hudson passenger coach and is handsomely finished. The passenger compartment is decorated in mahogany, with a birch wainscoting, the smoking room in quartered oak, and both the baggage and engine rooms in painted poplar. The outside of the car is painted and lettered in the standard Delaware & Hudson pattern, and Gould pattern bumpers and drawbars are provided.

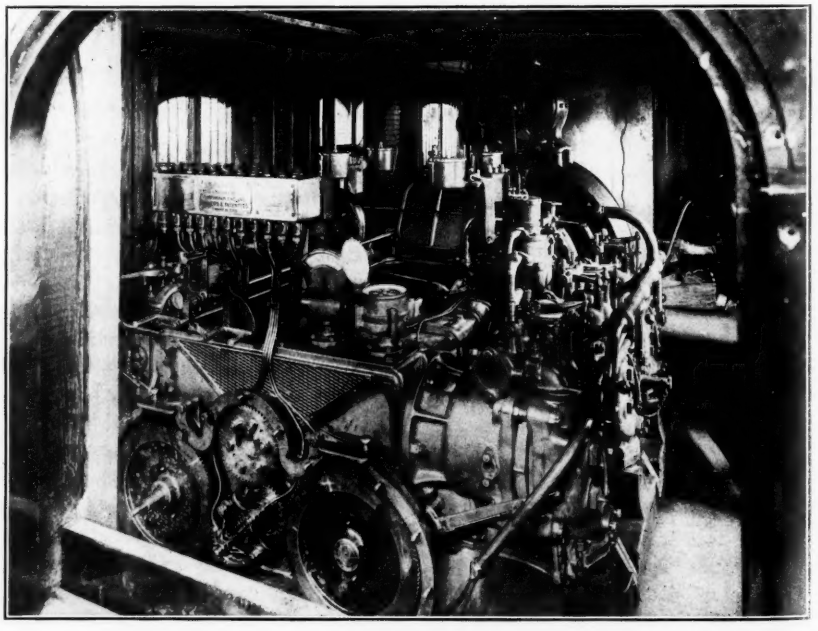
The gasoline engine for this car was built by the Wolseley Tool and Motor Car Company, Limited, of Birmingham, England, and is considered the most powerful unit yet constructed for this class of work; it develops 160 brake-horse-power at a speed of 450 revolutions per minute. The cylinders are horizontal opposed, six in number, nine-inch diameter, ten-inch stroke. All valves are mechanically operated and the cylinders are water-cooled. Hitherto, difficulty has been experienced in starting internal combustion engines of this size, but in the present case this has been entirely overcome by using shells filled with black powder to provide the initial charge in one cylinder.

On starting the engine the shell is fired by a hand trigger, the whole being similar to the breach mechanism of a gun. Jump spark and low-tension ignition are both provided, current being furnished to the latter by a small magneto driven from the engine shaft.

The volatilization of the liquid fuel is produced in two carburetors which form an integral part of the engine. Each carburetor supplies three cylinders and is equipped with two float feed chambers. The chambers are identical and are of the usual needle valve type. Very flexible arrangements are provided to govern the air supply so that it may be taken from the atmosphere or from the crank chamber, or from both, according to the conditions required. The mixture is heated



GASOLINE ELECTRIC CAR, SARATOGA, N. Y.



ENGINE ROOM OF THE DELAWARE & HUDSON GASOLINE ELECTRIC CAR, SHOWING 140-HORSE-POWER WOLSELEY ENGINE.

to the required temperature in a small chamber which itself is warmed by the exhaust. In all details the engine is very complete. The lubrication is especially so, being force feed for main bearings and pistons and drip feed for all other working parts. Gasoline is stored in steel tanks beneath the car and the burnt gases pass through the roof into mufflers, from which they exhaust into the air. The cooling system for the cylinders consists of radiating tubes, located on the top of the car. Water for cooling is contained in the engine base.

For heating the car a three-way cock is provided which by-passes the circulating water through the usual pipe heating system within the car.

The transmission is electrical, consisting of a generator and standard railway motors. Current is furnished by a 120-kilowatt, direct-connected General Electric six-pole generator designed for 600 volts. This generator is provided with commutating poles, which, in connection with the method of voltage control, permits a flexible operating system. Owing to the peculiar operating conditions of this system the generator, while retaining the characteristics of a shunt-wound machine, is separately excited by a five-and-one-half-kilowatt, two-pole, compound-wound exciter working at 110 volts. This is located on top of the generator and is driven by a Morse silent chain.

There are two G. E. 69 motors of standard railway construction similar to those used on the Interborough Rapid Transit Company, New York.

For regulating the speed of the motors, as mentioned above, voltage control is used; in other words, the speed of the car is governed by varying the field strength of the generator. With this method the speed of the engine remains constant after acceleration. The controller is semi-automatic and can be set for any predetermined maximum acceleration. It is arranged for series parallel control, the motor connections being changed from series to parallel by the reversing handle. This latter has five positions: "series ahead," "parallel ahead," "off," "series reverse" and "parallel reverse."

Arrangements are provided to prevent the motor connections from being changed from series to parallel until the resistance is put into the field circuit of the generator.

Further operating details comprise a General Electric combination, straight and automatic air-brake equipment and a special lighting equipment. Meridian lamps are used, equipped with Holophane reflectors, the whole affording a very satisfactory system for car lighting. The headlights are supplied with 100-candle-power incandescent lamps of the stereopticon type, one for each end of the car.

The trial trip of this car demonstrated the practicability of this equipment and was entirely satisfactory to the engineers and officials present so far as the tests indicated. The opinion was expressed that this was merely a step toward the final electrification of all service. A gasoline car would be useful in establishing a passenger traffic, but eventually the motive power for operation would be electricity.

The accompanying photograph of the car was taken after the arrival in Saratoga. Among the officials present from the Delaware & Hudson company were: Axel Ekstrom, consulting electrical engineer; J. H. Manning, superintendent of motive power; J. W. Burdick, passenger traffic manager; Jas. McMartin, chief engineer; J. B. Dixey, assistant to second vice-president; W. J. Mullin, assistant to second vice-president; D. F. Wait, superintendent of Susquehanna division; E. F. Peck, manager Schenectady Railway Company. From the General Electric Company: E. W. Rice, Jr., technical director; W. B. Potter, chief engineer; J. R. Lovejoy, general manager railway department; J. G. Barry, assistant manager railway department; W. J. Clark, manager transportation department; E. D. Priest, A. F. Bachelder and H. G. Chataine, of the railway engineering department; F. H. Gale, advertising department.

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

THE ECONOMICS OF WINDING BY ELECTRICITY AT COLLIERIES.

Mr. W. C. Mountain, of Newcastle-on-Tyne, recently read a paper before the Manchester section of the Institution of Electrical Engineers entitled "Electric Winding Considered Practically and Commercially." At a meeting of the Institution of Mining Engineers in London a little while ago, in the course of the discussion on the question of electrical winding, Mr. Mountain broached the idea that there are not many cases in this country where it will be economical to apply electricity to winding because of the very heavy cost of the electrical apparatus. In the paper referred to above, Mr. Mountain has returned to the charge and has given details of the costs of winding by steam and by electricity under different conditions. He gives the cost of winding at six large English collieries, where the total output ranges from 1,200 to 3,600 tons per day. The cost of winding by steam per 100 tons ranges from 2s. 7d. to 10s. 7¾d., these figures not including interest or depreciation. When these items are included the costs of winding by steam range from 3s. 11d. per 100 tons wound up to 19s. 10¾d. The last case, where the cost is so heavy, is an exceptional one. The average costs in Lancashire, Yorkshire and Nottinghamshire range from 4s. to 6s. 6d. per 100 tons wound, including all charges. Mr. Mountain also includes in his paper the cost of winding with specially designed plant consisting of high-class, high-pressure, non-condensing engines, the cost coming out at 5s. 5d. The estimated cost of winding by electricity, the output being 1,500 tons per day, he gives at 2s. 11½d. without interest or depreciation and 11s. 7d., including those items. The depth of the shafts from which coal is wound ranges from 370 up to 760 feet. It will be seen from the above that the cost given, 2s. 11½d. without interest and depreciation, does not compare unfavorably with the average costs by steam, being considerably less than many of them and only greater than one, in which a very large output—3,186 tons—is obtained by running two shifts. The increased cost of winding by electricity is produced almost entirely by the interest and depreciation upon the winding plant. Now all experience with electrical apparatus during the last thirty years has shown that the first cost and the running costs tend continually and steadily to decrease. When any particular problem has been first grappled with a very large amount of cash has been spent in solving it, and the apparatus which has been evolved and which has been placed on the market in the first instance has necessarily been expensive for that reason, for the reason that all new apparatus is expensive and for the reason that the market is very limited. Further, the running costs are always high in the first instances, because the initial cost is high and because the apparatus is subject to failure from causes which can not be foreseen until it is in practical use. As time goes on and as more experience is obtained with the apparatus, both running costs and first costs are reduced by the operation of the laws given above. In addition to the ordinary costs, there are always patent charges which have to be met with new apparatus and which are often very heavy.

Meeting of the Kansas Independent Telephone Association.

The Kansas Independent Telephone Association held its annual meeting at Wichita, Kan., January 22 and 23. The opening address was made by Mayor Ross, the response on behalf of the association being delivered by James A. Plotner, of Kansas City. Several committees were appointed. The most important committee was that appointed to draft a new constitution and by-laws. The chairman of this committee is W. H. Nelson. The other members are Messrs. Byers, Emery, Morris, Sharp, Hemphill and Robeson. W. R. Dilworth was made chairman of the auditing committee. George W. Watson was made chairman of the committee on credentials, and J. A. Zimmerman, chairman of the committee on resolutions.

Among the representatives of the different companies from the various parts of the state were the following: W. G. Miller, Citizens' Telephone Company, Atlanta, Kan.; F. W. Mackey, Columbian Electrical Company, St. Joseph, Mo.; Homer Caldwell, United Electrical Company, Wichita, Kan.; A. B. Clarke, Herington Telephone Company, Herington, Kan.; J. W. Smith and F. S. Flint, Minneapolis Telephone exchange, Minneapolis, Kan.; R. M. Emery, Seneca Telephone Company, Seneca, Kan.; C. C. Raymond, Lindsborg Telephone Company, Lindsborg, Kan.; R. H. Shore, Winchester Telephone and Electric Company; T. H. Youmans, Osawatomie Telephone Company, Osawatomie, Kan.; S. H. Williams, Southwestern Telephone Company, Meade, Kan.; Frank Lanley, Stafford Telephone Company, Stafford, Kan.; E. B. Kellan, Chase County Telephone Company, Cottonwood Falls, Kan.; R. C. Hall, Ellis Telephone Company, Ellis, Kan.; J. A. Zimmerman, Valley Falls Telephone Company, Valley Falls, Kan.; J. C. Kelsey, Kellogg Switchboard and Supply Company, Chicago, Ill.; J. C. Valentine, Northern Kansas Telephone Company, Effingham, Kan.; J. T. Elder, Home Telephone and Electric Company, Cunningham, Kan.; C. E. Betts, Atchison, Kan.; C. C. Vandeventer, Kingman Independent Telephone Company, Kingman, Kan.; F. M. Pearl, A. J. Stevens and Felix O'Neal, Northeast Kansas Telephone Company, Hiawatha, Kan.; C. S. Safford, Stromberg-Carlson Telephone Manufacturing Company, Ottawa, Kan.; W. P. Hemphill, Independent Telephone Company, Topeka, Kan.; W. R. Pettijohn, Hoyt Telephone Company, Hoyt, Kan.; George W. Watson, Kinsley Telephone Company, Kinsley, Kan.; W. W. Dilworth, Solomon Valley Telephone Company, Beloit, Kan.; W. H. Wilson, Exchange Telephone Company, Smith Center, Kan.; D. D. Brunwell and J. N. Doyle, Belleville Independent Telephone Company, Belleville, Kan.; C. A. Starr and B. F. Bess, Pratt, Kan.; C. B. Anderson, Wabunsee Telephone Company, Alma, Kan.; C. H. Cornwall, R. M. Cornwall and G. Z. Taylor, Mount Hope Telephone Company, Mount Hope, Kan.; F. A. Greshan, Home Telephone Company, Bucklin, Kan.; C. J. Rich, Haviland Telephone Company, Haviland, Kan.

W. P. Hemphill, of Topeka, addressed the convention on the subject, "Telephone Revenues." He gave his views as to the methods of operation which could be introduced to give better service and to make the systems more profitable.

The president of the association, General Goddard, delivered the annual address, reviewing the work of the association during the past year. General Goddard discussed the rate question, and was of the opinion that when the people were educated to understand the expense necessary in operating a large telephone system in an efficient manner they would not complain of the telephone rates.

J. C. Kelsey, who is well known in telephone circles, addressed the convention on the subject, "The Sub-Licensee Question."

Several members of the association delivered brief addresses on various topics of interest.

On Monday night a smoker was held at the Cary Hotel.

On Tuesday morning the session was again called to order. The programme included an address by F. M. Pearl, of Hiawatha, on "The Great Association;" a paper by C. J. Myers, Kansas City, on "Independent Toll Lines in Kansas;" a paper on "Uniform Accounting," by C. L. Brown, Abilene. The programme for the afternoon included a paper by C. H. Kimball, of Parsons, on "Consolidation of Telephone Companies," and a paper by Henry Hodges, of Paola, on "The Telephone a Commercial Necessity."

There was a very lively discussion at the afternoon session over the question of continuing the membership in the National-Interstate Telephone Association. Robert Burns, of Hutchinson, opposed the proposition and made a motion putting the matter in the hands of the executive committee, with power to act. A substitute motion was offered by Mr. Betts, of Atchison, instructing the executive committee to make an assessment to pay dues. Theodore Gary, vice-president of the National-Interstate Telephone Association, explained the work of that body.

After considerable discussion it was decided to remain in the National association, and the president was instructed to appoint such delegates as the Kansas association is entitled to for the next convention, to be held in St. Louis in June.

Following the discussion, officers were elected for the ensuing year, as follows: president, William H. Nelson, Smith Center; vice-presidents, C. F. Betts, Atchison; W. Miller, Olathe; A. E. Herzberg, Independence; Charles Henderson, Alma; John Doyle, sixth district; C. C. Vandeventer, Kingman; secretary and treasurer, F. M. Pearl, Hiawatha; member of advisory committee, National association, H. D. McVey, Wichita.

The selection of a meeting place for the next convention was left to the executive committee, although it is expected that Topeka will be the meeting place.

The following were appointed by President Nelson as members of the executive committee: J. R. Byers, Ottawa; A. P. Rogers, Beloit; Harry Camman, Winfield; R. M. Emery, Severance; C. L. Brown, Abilene.

Chicago Telephone Rates.

Negotiations between the city of Chicago and the Chicago Telephone Company for a reduction in the charges made to patrons of the corporation were begun on the morning of January 25 before the council committee on gas, oil and electric light. The telephone company was represented by President Arthur D. Wheeler, General Manager Angus S. Hibbard and Attorney Payne. Assistant Corporation Counsel Hoyne appeared for the city. President Wheeler made a statement in which he described the history of the company and the rapid growth of its business. He exhibited a large map showing the extensions made of its regular service and told of the many thousands of dollars expended by the corporation in the last few years for the improvement of the service. He explained that the rate of $125 a year, with an additional charge of $50 per year for copper circuits, is not exorbitant when the size and quality of the service is taken into consideration.

City Statistician Grosser was instructed to gather data on the telephone question and submit it to the committee. The committee adjourned to meet again at the call of the chairman to continue its investigation of the telephone problem.

Reception to Dr. Ostwald by the New York Section of the American Electrochemical Society.

The New York section of the American Electrochemical Society tendered a reception to Dr. William Frederick Ostwald at the Chemists' Club, 108 West Fifty-fifth street, New York city, Friday evening, February 2. Dr. Ostwald has been giving a series of lectures at Harvard University and had just completed a course of six lectures at Columbia University.

The assembly room of the Chemists' Club was very beautifully decorated for this occasion, an orchestra being hidden behind a bower of ferns. Dr. Ostwald was the guest of the reception committee of the society at a dinner given at the Savoy Hotel earlier in the evening. Dr. Ostwald and the reception committee arrived at the Chemists' Club about 9 P. M. Dr. C. A. Doremus, chairman of the New York section, opened the reception, welcoming the guests and Dr. Ostwald and introducing Dr. Joseph W. Richards, past-president of the American Electrochemical Society, to represent the national organization. Dr. Wilder D. Bancroft, president of the American Electrochemical Society, was unavoidably absent.

Dr. Richards welcomed the distinguished guest in the name of the 750 members of the society. He paid a glowing tribute to the work that Dr. Ostwald had done, and emphasized the absolute dependence of each generation upon the teachers, who not only presented what was science, but what is science. He said that he hoped that the enthusiasm that Dr. Ostwald had created would bear fruit and that the sacrifices he had made would not be in vain.

In introducing Professor C. F. Chandler, who welcomed Dr. Ostwald on behalf of the American Chemical Society and the Society of Chemical Industry, Dr. Doremus spoke reminiscently of his experiences in Leipsic under Dr. Bunsen, the predecessor of Dr. Ostwald. Professor Chandler spoke of the series of lectures which Dr. Ostwald had been conducting at Columbia University and made the statement that it was unfortunate that more of the chemists in the United States had not been able to be present at these lectures. He congratulated Dr. Ostwald upon the lucidity with which he had explained away so many abstruse problems, and made the statement that he represented the 5,000 chemists in the United States in expressing to Dr. Ostwald their appreciation of his remarkable researches.

Dr. Doremus then introduced Professor Morris Loeb, who presented a souvenir album to Dr. Ostwald as a memento of his reception in New York city. This album contains photogravures of many eminent American scientists, all of whom, Professor Loeb remarked, would have been glad to welcome Dr. Ostwald, had they been present. Dr. Loeb's remarks caused considerable enthusiasm, his many witty sallies creating amusement and interest. He explained to Dr. Ostwald that the chemists of the United States felt that his influence upon the progress of the scientific world was very much after the fashion of a catalytic action. They had always hoped that this catalytic action would not take place from afar, and their hope had been realized by having Dr. Ostwald present and receiving the catalytic effect by direct contact. He hoped that, unlike other catalytic agents who, when their work is done, depart and experience no change, Dr. Ostwald would feel that there had been a decided reaction in his case; that he would carry away with him many different views and a keen appreciation of the earnestness of the workers on this side of the water.

Dr. Ostwald thanked the society for its kindness to him. He said that his visit here had been a series of pleasant experiences. The main portion of his reply, however, was devoted to an appeal for scientists in general to embrace any opportunity for the establishing of a universal language. He called to mind his previous efforts in this direction and said that it was with great delight that he was cognizant of the organization of a society in New England with probably sixty members, who were determined to make every effort to create a language which would be universal. *Esperanza,* he maintained, would eliminate many difficulties in the propagation of scientific information. One of his books, written about six years ago, had been translated eight times. This he considered to be a waste of energy.

Following Dr. Ostwald's remarks, Dr. Doremus made a brief reply and declared the formal exercises of the evening closed. He extended a very cordial invitation to the guests to remain and meet Dr. Ostwald, and expressed the hope that every one present would thoroughly enjoy the refreshments which the society had placed at their disposal.

Dr. Ostwald returns to Leipsic during the present month, sailing from New York, February 6. Before leaving this side he expressed the hope that he would find the opportunity to return, not as a pedagogue, but as an observer, to visit some of the wonderlands of this country.

The Award of the Edison Medal for the Year 1906.

The Edison Medal Committee of the American Institute of Electrical Engineers is mailing a circular to the educational institutions of the United States and Canada regarding the award of the Edison medal for 1906. Sufficient funds will be available from the net income of the trust fund created in 1904 to establish the Edison medal, to provide for the award of the medal for the year 1906. Educational institutions eligible for the competition are requested to present students in competition for the medal and to take as soon as possible the steps necessary to this end.

The by-laws provide that not more than two students may compete in any one year from any one institution of learning qualified to present competitors. Each competing thesis or record of research must be the work of a single qualified student only. No student may compete unless he has graduated when not more than twenty-five years of age and received a degree during the year for which the medal shall be awarded in some course of study normally requiring not less than two years of continuous residence and work, which course of study shall include the branch of electrical engineering. Each student shall be separately presented through the faculty of the particular institution at which he is a student by means of a presentation notice properly filled in. Notices should be mailed to the secretary of the Institute as soon as possible after commencement this year and before September 1, 1906. The thesis or records of research themselves should be received by the secretary of the Institute by October 1.

Complete copies of the by-laws may be secured from Ralph W. Pope, secretary, American Institute of Electrical Engineers, 95 Liberty street, New York city.

Electricity for Athens Tramways.

Consul Horton, of Athens, Greece, reports that an electric tramway is to be extended between Athens and Piraeus, to be developed from the present horse and steam system. French and Belgian capitalists are to undertake the development. A delay was caused in granting the new concession because of the change in the Greek ministry. The present twenty-five-mile line will be transformed into a thirty-mile electric line and sixty per cent of it will be double-track. The electrical apparatus will be of American pattern, manufactured in Paris by the Thomson-Houston company. Further information may be secured from G. S. Albanese, care of the Greek Electric Company, Athens.

THE PROPER HANDLING OF CONSUMERS' METERS.[1]

BY GEORGE A. BARRETT.

There are a few general principles which seem to me might be followed by those in charge of a central station's meter department which will prove exceedingly profitable to the company, and at the same time tend to inspire in the consumer a confidence in the meter he otherwise might not have.

After carefully unpacking and numbering the meters the manufacturers' and company's number, together with the capacity and type of each, are recorded in a book kept especially for that purpose. The meters are taken to the testing room and subjected to a reasonably careful test.

I would urge that each company make its own test of all meters before placing them in service and not depend entirely on the factory test. It requires but little time and acts as a check on any mistakes which may be made by the manufacturer. It is a right beginning, and things begun right are more likely to remain so and produce correct results than things not so begun.

A hammer should never be used in fastening a meter to its support, nevertheless it is done and I fear oftener than you think. The old trick of the carpenter hammering a screw three-quarters or more of the way into place and then giving it a few turns with the screwdriver—provided the slot in the screw is not battered so badly that the screwdriver can not be inserted—is one which should never be resorted to in installing a meter. The proper tools and screws should always be at hand so that the meter may be securely fastened with the least possible jar.

Issue instructions to your men to install no meter until the wireman completes his work, which, among other things, would include the running of wires to some suitable location in the building for the installation of the meter. In installing a two-wire meter, where the system has a grounded neutral, great care should be exercised to see that the outside wire is connected to the fields of the meter, for if the neutral in the building becomes grounded the registration will be very small, if anything at all. This, I think, can not be too strongly emphasized.

After the meter has been installed and in service it should, ordinarily, give satisfactory results for a period of six months, when it should be inspected and cleaned and so far as possible brought to its original condition. In this I wish to be understood as saying that under ordinary conditions twice a year is sufficient to clean up and inspect meters.

A customer comes in to the company's office and makes complaint on the amount of his bill, and should be listened to attentively, and unless some reasonable explanation can be given to him by the office man—such as his bill covering a period of possibly five or six weeks on account of the date of the installation of his meter—the complaint should be turned over to the meter department for adjustment.

A man to adjust complaints of this kind must, in the first place, be intelligent; he must have tact, be polite and gentlemanly under any and all circumstances, be able to convince the customer—if he be open to conviction—that he understands his business. Approach him, if possible, in a manner that will gain his confidence, discuss the matter with him openly and frankly, explain to him the previous test of his meter, how, when, and where made, the result of such test. Inform him what you propose to do, invite him to accompany you and assist in the test if he cares to; in other words, get him interested in the operation of his meter.

To keep between fifteen hundred and twenty-five hundred meters registering accurately on light loads is no small task. To clean and give any kind of a thorough test at all, a man can not average more than eight or ten meters a day, if indeed he can do that much, which means not more than two hundred and fifty meters a month.

Two thousand meters would therefore require eight months' time to cover the entire system. That is to say, a man giving his whole time every day, with no other duties to perform, would not be able to visit each meter twice a year, as has been suggested would be good practice. But the question arises: is it necessary in the great majority of cases to more than clean up and adjust for light load? I think not. A meter on full, or even a medium load, is usually not far from correct; it is nearly always the light load accuracy that gives the central station manager cause for worry. The revenue lost from this source alone must be considerable.

Let a man take a voltmeter—and I speak now of lighting loads exclusively, not power—and knowing the voltage at which the lamps are burning he can arrive at approximately the amount of current passing through the meter, and by the aid of a stop-watch can in a very short time find what the meter is doing. It seems to me unnecessary to make a laboratory test of each meter at every visit. To clean the commutator, remove all dust, cobwebs, etc., examine the jewel and pivot and insert new ones where necessary; and making a rough test, such as described above, ought not to occupy or exceed from twenty to thirty minutes. On the other hand if he must, in addition to cleaning and inspecting the meter, disconnect it from the circuit, connect in his indicating instrument and make a careful test on all loads, the time consumed in the operation will be probably double that which it was in the other case. And even then the test is often very unreliable unless there are two men present, one to read the indicating instrument and note the fluctuations, the other to time the revolutions of the disc of the meter under test. It is true that such tests are often found necessary and of course should be made, but in the large majority of cases the simpler method will be found to answer the purpose very well.

In most, if not all, of the larger plants where it is not feasible for the manager to give the time to it, some system of inspection should be followed by some one, preferably by the head of the meter department, who has an intimate knowledge of the various conditions under which the meter or its readings may be faulty. The ordinary bill clerk takes the readings as they are handed to him by the meter readers, enters them in the record book and makes out the bill whether large or small, except possibly in extreme cases. This would not be so serious if we were to hear of the low readings as quickly as we do the high ones. The customer can be depended on to notify of overreadings or fast meters, but the slow ones, that is another story. For instance, the jewel becomes cracked or chipped, which would cause the meter to record less than it ought to—this is not detected by the bill clerk—the damaged jewel is rapidly getting in worse condition, the readings become less and less, till finally the meter stops entirely. Then, and not till then, in too many cases is it turned over to the meter department to locate the trouble. Now, if some plan were adopted whereby every reading is scrutinized very carefully by some one having particular knowledge of the meter and its weaknesses, very material saving would result.

[1] Abstract of a paper read before the Northwestern Electrical Association, Chicago, Ill., January 17–18, 1906.

A telephone cable is to be laid across lake Constance, according to an agreement between the bordering counties, Wurtemburg, Bavaria and Switzerland, using the Pupin loading coil. This cable, which is nine miles long, has been ordered by the Wurtemburg postal administration.

POWER PLANT ECONOMICS.[1]

BY HENRY G. STOTT.

Three years ago the steam-power plant for the generation of electricity had apparently settled down to an almost uniform arrangement of standard apparatus in which one power plant differed from another only in details of construction of engines, generators and auxiliaries. As only about twenty years had then elapsed since the first central station was put in operation on a commercial basis, this uniformity of design seemed to indicate that in the near future it would only be necessary to purchase a standard set of power-plant drawings, and make the necessary changes in size of units in order to have a station of the best type known to the art.

The internal combustion or gas engine had from time to time been brought forward as a candidate for the position of prime mover, with every prospect of improved economy in fuel consumption; but with the exception of a few special instances it was not looked upon with favor, as shown by the almost universal use of the steam engine.

After a long period of development a new factor in power plant design; namely, the steam turbine, was placed on the market in commercial sizes. It is safe to say that during the last three years no other piece of apparatus has had so stimulating an effect upon the power plant. Its effect upon the entire plant has been most beneficial, for it has revived the apparently moribund superheater. This has now been so developed and improved that superheat of 200 degrees or 300 degrees Fahrenheit can be safely and economically obtained. With the development of the superheater further study of the problem of combustion has improved the efficiency of the furnace; and this most important subject is apparently susceptible of still further development.

One other important result of the steam turbine development has been the development of condensing apparatus to such a point of efficiency that a vacuum within one inch of the simultaneous barometer reading can now be maintained without difficulty.

Another change in the power plant has been the reversion to high-speed generators, resulting in decreased cost of the generator and its foundations, as well as saving in floor space.

Last, but not least, the steam turbine has put the reciprocating engine and the gas engine on the defensive and has actually been unkind enough to throw out hints in regard to the application of Dr. Osler's proposed methods to the treatment of older apparatus.

The reciprocating engine and internal combustion engine have not been slow in accepting this challenge; they have responded by showing so improved an economy (especially in the gas engine) that the situation has become most interesting to the power plant designer. It is safe to say that the developments of the next ten years will show very marked improvement in power plant efficiency.

In regard to this development the author wishes to direct attention to the basic fact that in power plants one should not look merely for increased efficiency in the prime mover, but should also investigate and analyze the entire plant from the coal to the bus-bars; first, in regard to efficiency; secondly, in regard to the effect of load-factor upon investment; and thirdly, the effect of the first and second upon the total cost of producing the kilowatt-hour, which is the ultimate test of the skill of the designer and operator.

EFFICIENCY.

In table 1 will be found a complete analysis of the losses found in a year's operation of what is probably one of the most efficient plants in existence to-day and, therefore, typical of the present state of the art.

TABLE NO. I.

ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL INTO ELECTRICITY.

	B. T. U.	Per Cent.	B. T. U.	Per Cent.
1. B. T. U. per pound of coal supplied	14,150	100 0	..	..
2. Loss in ashes	..	..	340	2.4
3. Loss to stack	..	..	3,212	22.7
4. Loss in boiler radiation and leakage	..	..	1,131	8.0
5. Returned by feed-water heater	441	3.1	..	..
6. Returned by economizer	960	6.8	..	..
7. Loss in pipe radiation	..	..	28	0 2
8. Delivered to circulator	..	..	223	1.6
9. Delivered to feed-pump	..	..	203	1.4
10. Loss in leakage and high-pressure drips	..	.	152	1.1
11. Delivered to small auxiliaries	..	..	51	0.4
12. Heating	..	..	31	0.2
13. Loss in engine friction	..	..	111	0.8
14. Electrical losses	..	..	36	0.3
15. Engine radiation losses	..	..	28	0.2
16. Rejected to condenser	..	..	8,524	60.1
17. To house auxiliaries	..	..	29	0.2
	15,551	109.9	14,099	99.6
	14,099	99.6	..	..
Delivered to bus-bar	1,452	10.3	..	..

DISCUSSION OF DATA IN TABLE 1.

Item 1. British Thermal Units per Pound of Coal Supplied—The thermal value of the coal used is evidently of prime importance, as it affects the cost efficiency of the entire plant. The method of purchasing coal used in the plant from which this heat balance is derived is that of paying for British thermal units only, with suitable restrictions on the maximum permissible amount of volatile matter, ash and sulphur.

A small sample of coal is automatically taken from each filling of the weighing hoppers, so that the final sample represents a true average of a boat-load of coal. This final average sample is then pulverized and tested for heat value in a bomb calorimeter, after which a proximate analysis is made of another portion of the sample. This method of purchasing coal has been in use for two years, with highly satisfactory results.

Item 2. Loss in Ashes—It is doubtful whether a further saving in this item can be made, as the extra care and labor necessary to accomplish any improvement would in all probability offset the saving in coal.

Item 3. Loss to Stack—This is one of the most vulnerable points to attack, as the loss of 22.7 per cent is very large. Recent investigations show that promising results may be obtained by the use of more scientific methods in the boiler room. In practically all cases it will be found that this loss is due almost entirely to admitting too much air to the combustion chamber, resulting in cooling of the furnace. This result is usually produced by "holes" in the fire; these "holes" may be due to several causes, but usually are due to carelessness on the part of the fireman.

Fortunately, a very valuable piece of apparatus has been placed upon the market in the shape of a CO_2 recording instrument. From a series of tests made with this instrument it seems reasonable to assume that the 22.7 per cent loss to stack can, by scientific methods in the fire room,

[1] A paper read before the American Institute of Electrical Engineers, New York, January 26. Abridged.

be reduced to about 12.7 per cent and possibly to ten per cent.

Fig. 1 shows the calculated losses in fuel corresponding to various percentages of CO_2 for three different temperatures of flue gases.

Before the installation of the CO_2 recorder a long series of evaporative tests was made to determine the most economical draught to carry when a high-grade semi-bituminous coal was burning on the automatic stokers. The results shown in Fig. 2 were so remarkable that they were repeated under different conditions in order to confirm them. Since the installation of the CO_2 recorder, however, the explanation is apparent; as the draught giving maximum evaporation per pound of combustible corresponds to the point of maximum CO_2, illustrating the inherent difficulty of maintaining efficient conditions in the combustion chamber with high draught.

Item 4—The loss in boiler radiation and leakage, amounting to eight per cent, is largely due to the inefficient boiler setting of brick which, besides permitting radiation, admits a large amount of air by infiltration. This infiltration will increase with the draught, thus tending to exaggerate the maximum and minimum points on Fig. 2. The remedy for this radiation and infiltration loss is evidently to use new methods of boiler setting, such as an iron plate air-tight case enclosing a carbonate of magnesia lining outside the brickwork.

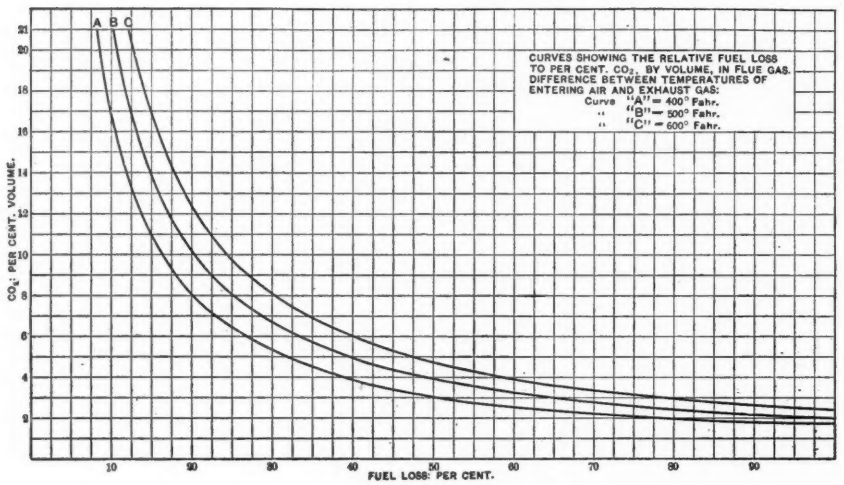

A B C
CURVES SHOWING THE RELATIVE FUEL LOSS TO PER CENT. CO_2 BY VOLUME, IN FLUE GAS. DIFFERENCE BETWEEN TEMPERATURES OF ENTERING AIR AND EXHAUST GAS:
Curve "A" = 400° Fahr.
" "B" = 500° Fahr.
" "C" = 600° Fahr.
CO_2 PER CENT. VOLUME.
FUEL LOSS: PER CENT.

FIG. 1.—RELATIVE FUEL LOSS.

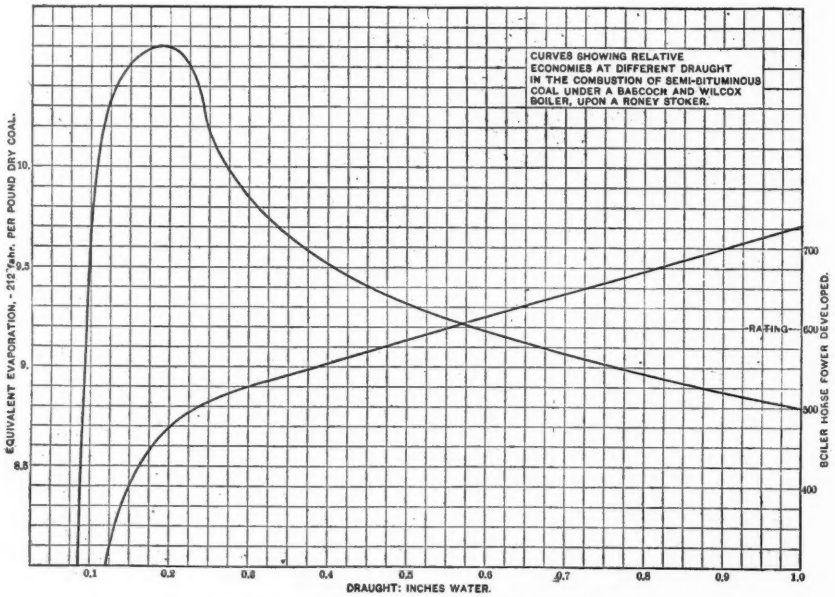

CURVES SHOWING RELATIVE ECONOMIES AT DIFFERENT DRAUGHT IN THE COMBUSTION OF SEMI-BITUMINOUS COAL UNDER A BABCOCK AND WILCOX BOILER, UPON A ROney STOKER.
EQUIVALENT EVAPORATION, - 212° Fahr. PER POUND DRY COAL.
RATING
BOILER HORSE POWER DEVELOPED.
DRAUGHT: INCHES WATER.

FIG. 2.—RELATIVE ECONOMIES AT DIFFERENT DRAUGHT.

Mr. W. H. Patchell,[1] of London, who recently visited us, has introduced very large boilers, assembling two in one setting; each boiler has a normal evaporation of 33,000 pounds per hour and in this way has cut down to a minimum the radiating surface per square foot of heating surface. He has also introduced the iron case with magnesia lining and with good results.

The question of boiler leakage is one in which the choice of the lesser of two evils is necessary; for in the tubular or cylindrical boiler the leakage will undoubtedly be less than in the water tube type, owing to the smaller number of joints in the water space. But these two advantages are offset by the increased difficulty of construction and the danger of using large boilers of the tubular type, especially with high-pressure steam.

It is now generally admitted that there can be no more difference in the efficiency of different types of boilers under similar conditions than there can be in electric heaters, press agents to the contrary notwithstanding.

Item 5. Returned by Feed-Water Heater—The importance of getting the feed-water to the maximum temperature obtainable is generally recognized, and would seem to indicate that all auxiliaries should be steam-driven, so that their exhaust may be utilized in the feed-water heater; in this way the auxiliaries may operate at about eighty per cent thermal efficiency.

Item 6—Owing to the difficulty of pumping water at temperatures above 150 degrees Fahrenheit, when under pressure, it becomes necessary to install economizers for the purpose of increasing the feed-water temperature to 200 or 250 degrees Fahrenheit. As this increase of temperature is obtained from the waste gases at no expense for fuel, it only becomes necessary to consider the load-factor, as will be shown later, in order to decide whether economizers should be installed or not. In practically all cases where the load-factor exceeds twenty-five per cent the investment will be justified.

In deciding upon the size of economizer to be installed, it is important to consider first, the influence of the economizer upon the available draught due to the obstruction it offers and also due to the reduced stack temperature; the second important consideration is to equate the interest and depreciation charges against the saving in fuel, and so determine the amount of investment justified in each particular case.

Item 7. Loss in Pipe Radiation—By the use of two-layer pipe covering, each layer being approximately 1.5 inches thick and sections put on in such manner that

[1] See paper read December 7, 1905, before the Institution of Electrical Engineers, by W. H. Patchell.

all joints are broken, the radiation losses have become practically negligible.

Items 8 and 9. Heat Delivered to Circulating and Boiler-Feed Pumps—As these auxiliaries may be either electrically driven or steam driven it is interesting to note that the thermal efficiency of the electrically driven pumps would be equal to the thermal efficiency of the plant, multiplied by both the efficiency of conversion from the alternating to direct current and by the motor efficiency. In this case there would be a net thermal efficiency of 10.3 $\times$ 0.93 $\times$ 0.90 = 8.63 per cent, whereas the thermal efficiency of the steam-driven auxiliary discharging its exhaust into a feed-water heater at atmospheric pressure would be approximately eighty-seven per cent.

Item 10. Loss in Leakage and High-Pressure Drips—The loss in leakage should be infinitesimal, and the high-pressure drips can be returned to the boiler, so that practically all the loss under this heading is recoverable.

Items 11, 12 and 17 are probably unavoidable and of so small a magnitude as not to merit much consideration.

Item 13. Loss in Engine Friction—Recent tests of a 7,500-horse-power reciprocating engine show a mechanical efficiency of 93.65 per cent at full load, or an engine friction of 6.35 per cent. As this forms only 0.8 per cent of the total thermal losses it is relatively unimportant. Attention is called to the method of lubricating all the principal bearings by what is known as the flushing system, whereby a large quantity of oil is put through all the bearings by gravity feed from elevated oil reservoirs common to all the units; after passing through the bearings the oil is returned by gravity to oil filters in the basement and then pumped up to the reservoir tanks again. About 200 gallons per hour are put through each engine, and of this quantity only about 0.5 per cent is lost. This method of oiling undoubtedly contributes to the general result.

Item 14—As large electrical generators can now be obtained which give from 98 to 98.5 per cent efficiency, it would seem as if the limit in design had been reached and that hereafter the problem of design is to be merely one of altering dimensions to suit varying sizes and speeds. While this is true as far as the efficiency is concerned, other problems are continually arising, such as the design of generators for an overload capacity of 100 per cent to meet the demand for apparatus capable of taking care of great overloads economically for short periods, corresponding to peak loads of a railroad or lighting plant.

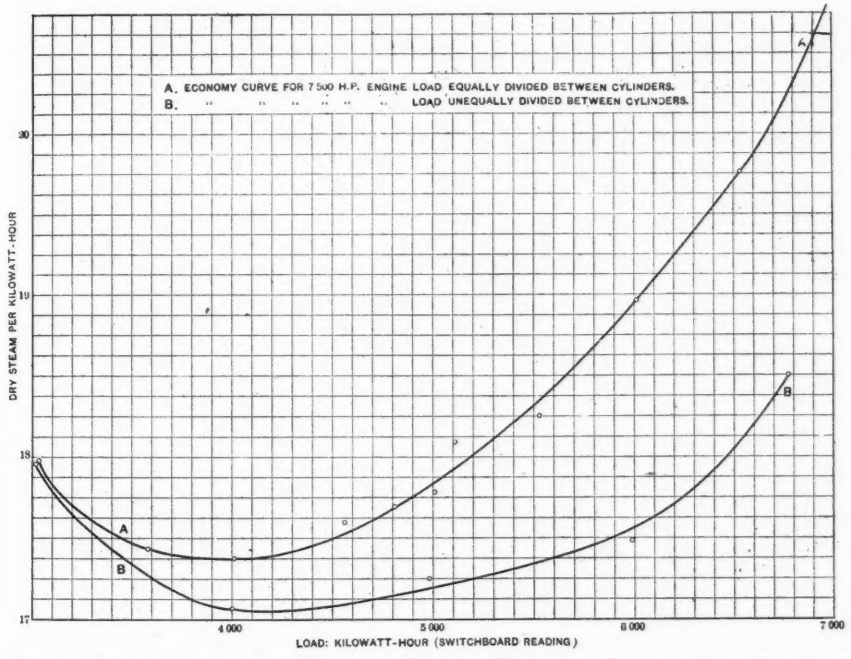


FIG. 3.—ECONOMY CURVES FOR EQUAL AND UNEQUAL DIVISION OF LOAD BETWEEN CYLINDERS.

Item 15. Engine Radiation Losses—This source of loss has evidently been reduced to a negligible quantity by the use of improved material and methods of heat insulation.

Item 16. Rejected to Condenser, 60.1 Per Cent—This immediately introduces the thermodynamics of the steam engine, a subject so broad that it will be impossible to do more than touch upon some of the most important points in considering steam engine efficiency.

The efficiency of any heat engine can be expressed by the ratio of $E = \frac{T_1 - T_2}{T_1}$ where T_1 is the absolute temperature of the steam entering the engine and T_2 the absolute temperature of the steam leaving the engine. Thus in the engine whose steam consumption curve is given in Fig. 3, if the initial pressure is 175 pounds gauge and the vacuum at the low-pressure exhaust nozzle is 28 inches, then the maximum thermal efficiency is $\frac{837 - 560}{837} = 33$ per cent. This would be true for any form of engine or turbine working between the same temperature limits.

In Fig. 3, however, it is seen that the point of maximum economy shows a steam consumption of approximately seventeen pounds per kilowatt-hour, which is equivalent to 20,349 British thermal units per hour. One kilowatt-hour is equal to 3,412 British thermal units per hour, so that the actual efficiency of the steam engine and generator is $= \frac{3,412}{20,349}$ = 16.7 per cent. As the generator efficiency at this load is approximately ninety-eight per cent the net engine thermodynamic efficiency is $\frac{16.7}{0.98} = 17$ per cent.

The difference between the theoretical efficiency and the actual is then 33 — 17 = 16 per cent, of which 0.8 per cent has already been accounted for in engine friction, so that the balance of 15.2 per cent is due to cylinder condensation, incomplete expansion and radiation.

As the engine friction in a two-bearing engine with high-pressure poppet valves and low-pressure Corliss valves has, by careful design, been reduced to less than 0.8 per cent gain can not be expected here, so attention must be centered on the loss due to cylinder condensation, etc., amounting to 15.2 per cent, in order to effect any improvement.

Superheated steam is the only remedy at hand and with it we can probably effect an improvement of five or six per cent by using such a degree of superheat in the boilers that dry steam will be had at the point of cut-off in the low-pressure cylinder.

Any greater amount of superheat than this will merely result in loss to the condenser; for it should be remembered that the cylinder losses increase with the difference in temperature between the steam and exhaust portion of the cycle; in other words, the greater the thermal range of temperature the greater the condensation

loss. This would seem to point to the use of more cylinders; but this involves additional first cost and friction as well as more space and higher maintenance charges.

Something may be gained by reducing the temperature at the end of the cycle by means of increased vacuum, but in the case in point the maximum vacuum obtainable in practice was used so that no additional economy can be expected in this way.

SUMMARY OF ANALYSIS OF HEAT BALANCE.

The present type of power plant using reciprocating engines can be improved in efficiency as follows:

	Per Cent.
Reduction of stack losses	12
" in boiler radiation and leakage	5
Reduction in engine losses by the use of superheat	6

resulting in a net increase of thermal efficiency of the entire plant of 4.14 per cent, and bringing up the total thermal efficiency from 10.3 per cent to 14.44 per cent.

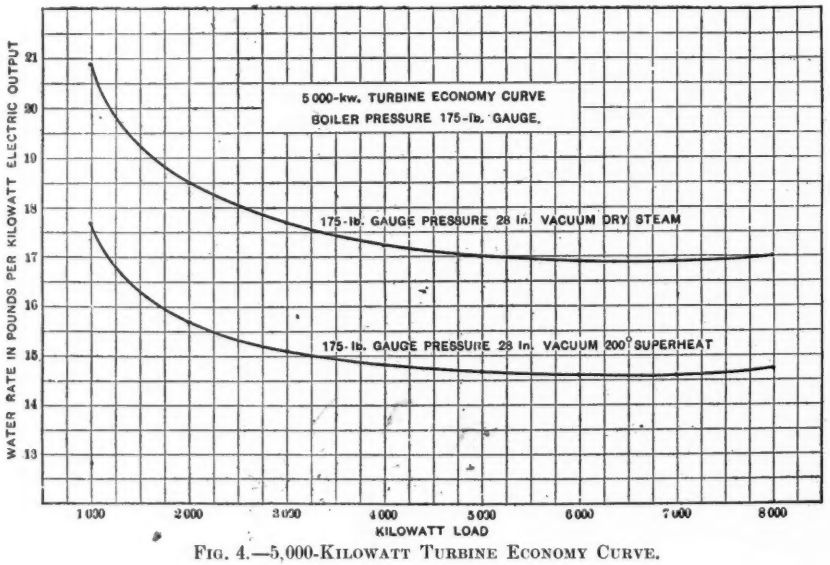


FIG. 4.—5,000-KILOWATT TURBINE ECONOMY CURVE.

THE STEAM TURBINE.

A typical economy curve of a steam turbine is shown in Fig. 4. An inspection of this curve, which represents what is probably the best results obtained up to date, shows: first, that the best economy on dry saturated steam is practically equal to that of the reciprocating engine in Fig. 3; secondly, that 200 degrees superheat reduces the steam consumption 13.5 per cent. But calculating the total heat units in superheat from $H_1 = H + 0.48 (t_2 - t_1)$ the British thermal units per kilowatt-hour are 20,349 for dry saturated steam, while for 200 degrees superheat they are 19,008 or a net thermal saving of 6.6 per cent. The shape of the economy curve, however, is much flatter than that of the reciprocating engine, so that the all-day efficiency of the turbo unit would be considerably better than that of the reciprocating engine, with the other great advantage of costing approximately thirty-three per cent less for the combined steam motor and electric generator.

HIGH-PRESSURE RECIPROCATING ENGINE WITH LOW-PRESSURE TURBINE ON ITS EXHAUST.

The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke as in the reciprocating engine; there is an almost ideal thermal drop from the steam valve to the condenser. It is also evident that the expansion will be relatively more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, so that it has been proposed that the reciprocating engine should be run high pressure where relatively it is more efficient than the steam turbine, utilizing the turbine for the low-pressure part of the cycle. In other words, use each where it is most efficient.

The following calculations show approximately what might be expected from such a combination. Assuming that the 5,000-kilowatt reciprocating unit would take fifty per cent more steam when operating non-condensing than when condensing there would then be (see Fig. 3) a consumption per kilowatt-hour of 25.5 pounds.

Steam expanding between the absolute pressure of 190 pounds and 14.7 pounds would give up 165.3 British thermal units per pound, or a total of 4,215 British thermal units per kilowatt-hour.

The total heat in the steam at 190 pounds absolute is 1,197, so that the heat units left for the turbine would be

$(1{,}197 \times 25.5 - 4{,}215) \times 5{,}000 = 131{,}542{,}500$ British thermal units.

The British thermal units per kilowatt-hour for a turbine unit operating on dry saturated steam (see Fig. 3) were 20,349, but owing to the wetness of the steam at atmospheric pressure the efficiency of the turbine would in all probability be reduced to about seventy per cent, so that the steam consumption of the low-pressure turbine would be increased to 29,070 British thermal units. The total power available from the turbo-generator would then be 4,807 kilowatts.

We thus find that for a total of 152,617,500 British thermal units we now get 5,000 kilowatts from the reciprocating unit, and 4,807 kilowatts from the turbo unit or a total of 9,807 kilowatts at a cost of 15,562 British thermal units per kilowatt-hour.

This turbo unit would be interposed directly between the exhaust nozzle of the reciprocating engine and the condenser, and would have no valves or governing mechanism whatever. The generator would be connected directly to the other generator leads without any switching apparatus, except possibly knife switches to disconnect for testing purposes; and in operation no attention whatever would be required beyond the ordinary lubrication of bearings. Such a unit it is evident could be built at a very small cost per kilowatt-hour.

THE INTERNAL COMBUSTION OR GAS ENGINE.

The gas engine has probably developed more slowly than any other piece of modern apparatus, as it is now thirty years since the Otto gas engine was introduced. It is only within the last ten years that the larger type of engine, from 500 to 2,000 horse-power in size, has appeared. The delay in bringing forward the most efficient motive power known is chiefly due to the difficulty experienced in developing an efficient and inexpensive method of making gas. As far as the production of gas from anthracite and non-caking bituminous coals is concerned, this problem has apparently been solved, but it is still in a more or less unsolved condition for the richer bituminous and semi-bituminous caking coals of the eastern states.

The following heat balance is believed to represent the best results obtained in

Europe and the United States up to date in the formation and utilization of producer gas:

ANALYSIS OF THE AVERAGE LOSSES IN THE CONVERSION OF ONE POUND OF COAL CONTAINING 12,500 B. T. U. INTO ELECTRICITY.

	B.T.U.	Per Cent.
1. Loss in gas producer and auxiliaries	2,500	20.
2. Loss in cooling water in jackets	2,375	19.
3. Loss in exhaust gases	3,750	30.
4. Loss in engine friction	813	6.5
5. Loss in electric generator	62	0.5
6. Total losses	9,500	76.0
7. Converted into electrical energy	3,000	24.0
	12,500	100.0

The great objection to the use of the gas engine for electrical purposes has been: first, its lack of uniform angular velocity; secondly, its uncertainty in action and high cost of maintenance; and thirdly, its inability to carry heavy overloads. Recent developments have removed the first and second objections; and a period of vigorous development has resulted in placing the gas engine in the front rank of claimants for attention as a prime mover.

The total investment for a gas producer plant, all auxiliaries, gas engines and electric generators, has been reduced by the elimination of the gas-holding tank to a point where it is now practically on a par with a first-class steam plant using high-grade reciprocating engines.

Where natural gas or blast-furnace gas can be obtained the gas engine has outdistanced all competitors; and now that some of our large manufacturers have taken up in earnest the problem of designing producer gas plants, it is safe to say that rapid developments will result.

The records of operation of several important installations of gas engines in power plants abroad and in this country seem to indicate that only one important objection can be raised to this prime mover, and that is that its range of economical load is practically limited to between fifty per cent load and full load, as shown in Fig. 5. This lack of overload capacity is probably a fatal defect for the ordinary power plant, more especially for the average railroad plant operating under a violently fluctuating load, unless protected by a storage battery of comparatively large capacity.

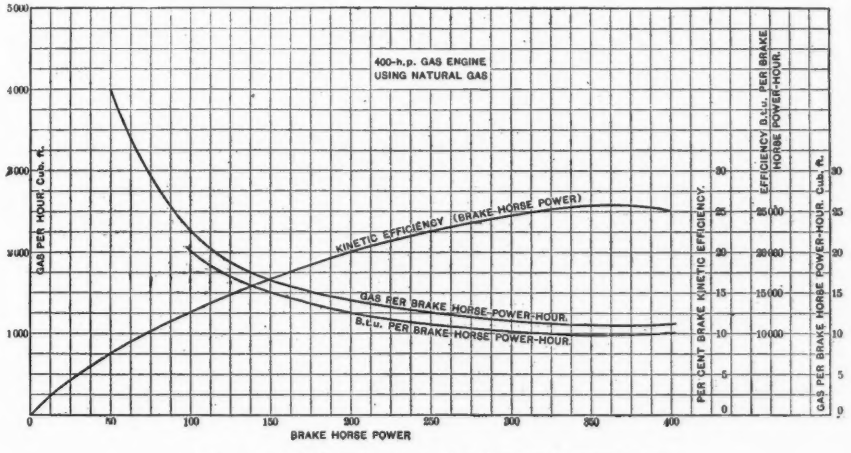

400-h.p. GAS ENGINE
USING NATURAL GAS
KINETIC EFFICIENCY (BRAKE-HORSE POWER)
GAS PER BRAKE HORSE-POWER-HOUR.
B.t.u. PER BRAKE HORSE POWER-HOUR.
GAS PER HOUR Cub. ft.
PER CENT BRAKE KINETIC EFFICIENCY.
EFFICIENCY B.t.u. PER BRAKE HORSE POWER-HOUR.
GAS PER BRAKE HORSE POWER-HOUR. Cub. ft.
BRAKE HORSE POWER

FIG. 5.—400-HORSE-POWER GAS ENGINE EFFICIENCY.

NEW TYPE OF PLANT.

Over a year ago, while watching the effect of putting a large steam turbine having a sensitive governor in multiple with reciprocating engine-driven units having sluggish governors, it occurred to the author that here was the solution of the gas-engine problem; for the turbine immediately proceeded to act like an ideal storage battery; that is, a storage battery whose potential will not fall at the moment of taking up load, for all the load fluctuations of the plant were taken up by the steam turbine, and the reciprocating units went on carrying almost constant load, while the turbine load fluctuated between cipher and 8,000 kilowatts in periods of less than ten seconds.

The combination of gas engines and steam turbines in a single plant offers possibilities of improved efficiency, while at the same time removing the only valid objection to the gas engine.

A steam-turbine unit can easily be designed to take care of 100 per cent overload for a few seconds; and as the load fluctuations in any plant will probably not average more than twenty-five per cent with a maximum of fifty per cent for a few seconds, it would seem that if a plant were designed to operate normally with fifty per cent of its capacity in gas engines and fifty per cent in steam turbines, any fluctuations of load likely to arise in practice could be taken care of.

We have seen that the thermal losses in the gas-engine jacket-water amounted to approximately nineteen per cent, and as the water is discharged at a temperature above 100 degrees it can be used to advantage for boiler feed.

The jacket-water necessary for an internal combustion engine will probably be about forty pounds per kilowatt-hour, assuming that the jacket-water enters at fifty degrees Fahrenheit; then the discharge temperature will be

$$50 + \frac{19 \times 12{,}500}{40 \times 100} = 109.4^\circ \text{ Fahrenheit.}$$

As the steam turbine will require only about fifteen pounds per kilowatt-hour, including auxiliaries, it is evident that only 37.5 per cent of this heat or 7.1 per cent of the jacket-water loss can be utilized. The other loss in the exhaust gases of thirty per cent can be utilized either in economizers or directly in boilers or superheaters.

Thus by utilizing the waste heat in the gas engines for the purpose of assisting to make steam for the turbines, there can be saved approximately thirty-seven per cent of the total heat lost in the gas engine.

In the summary of analysis of heat balance it was shown that one can reasonably expect to bring the reciprocating engine plant up to a maximum total thermal efficiency of 14.44 per cent or possibly with steam turbines using superheat, to fifteen per cent.

Referring now to table 1 it will be noted that in item 2 the loss in ashes was 2.4 per cent, and the loss to stack in item 3 was 22.7 per cent; now with the hot gases from the gas-engine exhaust it is evident that the loss in two will not exist, and that item 3 will be reduced from 22.7 per cent to about five per cent as the process of combustion is completed in the gas engine. The total efficiency of conversion of this thirty per cent of heat from the waste gases when used in the turbine plant would then be $15.0 + 2.4 + (22.7 - 5) = 35.1$ per cent.

The heat recoverable from the jacket-water was shown to be 7.1 per cent of the total heat in the coal so that there is 30 per cent + 7.1 per cent = 37.1 per cent of the original heat in the fuel returned from the gas engine, and this can be converted into electrical energy at an efficiency of 35.1 per cent.

For each kilowatt delivered by the gas-engine plant, 3,918 British thermal units will be simultaneously turned over to the steam plant, and this in turn will give 403 watts to the steam plant free of cost.

The steam plant will then have only to furnish 1,000 — 403, or 597 watts per

kilowatt at a thermal efficiency of fifteen per cent; in other words, the economy of the steam part of the plant will be raised to $\frac{15}{0.597} = 25$ per cent.

The average total thermal efficiency of such a combination plant would then be $\frac{24 + 25}{2} = 24.5$ **per cent.**

LOAD-FACTOR AND INVESTMENT.

In Fig. 6 the interest depreciation and

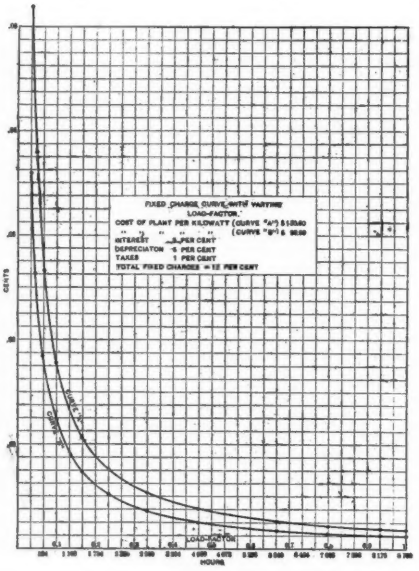


FIG. 6.—FIXED CHARGE CURVE WITH VARYING LOAD-FACTOR.

taxes on a plant costing $13 per kilowatt, which may be taken to represent a first-class steam or internal combustion plant, is shown plotted in conjunction with various load-factors.

Another curve is plotted showing the minimum investment with a plant in which the prime mover would be steam turbines and designed otherwise without regard to efficiency, leaving out economizers, feed-water heaters, etc., and thus reducing the investment to $90 per kilowatt. This cheap and relatively inefficient part of the plant would only be operated on peak loads of two or three hours' duration, corresponding to a load-factor of 0.1 or less found in possibly forty per cent of the output of our lighting plants.

In table 2 will be found a tabulation of the relative values of the various items necessary in the maintenance and operation of a power plant. The first column covers a plant with compound-condensing reciprocating engines without superheat, and is derived from a year's record of actual costs of a large plant operating with a load-factor of approximately fifty per cent; load-factor in this case being defined as

$$\frac{\text{Actual output}}{\text{Maximum hour's load} \times 24}$$

The values in the other columns have in the main been estimated from the first column, but wherever possible actual data derived from various sources, both domestic and foreign, have been used; but in all cases all values have been reduced so as to make them directly comparable with the first column, and with one another. The values in maintenance and operation of steam turbines are derived from actual costs.

SUMMARY.

1. The present type of steam power plant can be improved in efficiency about twenty-five per cent by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

2. The steam turbine plant has an inherent economy twenty per cent better than the best type of reciprocating engine plant, not so much due to its higher thermal efficiency as to a variety of causes as shown in table 2.

3. An internal combustion engine plant in combination with a steam turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one-half its present cost.

TABLE II.

DISTRIBUTION OF MAINTENANCE AND OPERATION. CHARGES PER KILOWATT-HOUR.

	Reciprocating Engines.	Steam Turbines.	Reciprocating Engines and Steam Turbines.	Gas-Engine Plant.	Gas Engines and Steam Turbines.
MAINTENANCE.					
1. Engine room mechanical	2.57	0.51	1.54	2.57	1.54
2. Boiler room or producer room	4.61	4.30	3.52	1.15	1.95
3. Coal and ash-handling apparatus	0.58	6.54	0.44	0.29	0.29
4. Electrical apparatus	1.12	1.12	1.12	1.12	1.12
OPERATION.					
5. Coal and ash-handling labor	2.26	2.11	1.74	1.13	1.13
6. Removal of ashes	1.06	0.94	0.80	0.53	0.53
7. Dock rental	0.74	0.74	0.74	0.74	0.74
8. Boiler room labor	7.15	6.68	5.46	1.79	3.03
9. Boiler room oil, waste, etc	0.17	0.17	0.17	0.17	0.17
10. Coal	61.30	57.30	46.87	26.31	25.77
11. Water	7.14	0.71	5.46	3.57	2.14
12. Engine room mechanical labor	6.71	1.35	4.03	6.71	4.03
13. Lubrication	1.77	0.35	1.01	1.77	1.06
14. Waste, etc	0.30	0.30	0.30	0.30	0.30
15. Electrical labor	2.52	2.52	2.52	2.52	2.52
Relative cost of maintenance and operation	100.00	79.64	75.72	50.67	46.32
Relative investment in per cent	100.00	82.50	77.00	100.00	91.20

Power Production and Coal Resources.

During a recent address delivered by Mr. George T. Beilley at Glasgow, Scotland, he pointed out the saving in fuel which might be effected by the introduction of modern machinery. It is estimated that at the present price the steam engines and boilers of Great Britain have an output of 5,000,000 horse-power and that these consume coal at a rate of about five pounds per indicated horse-power-hour. This amounts to about 40,000 tons per year. The actual figure for coal consumption was 53,000,000 tons. By substituting gas engines and steam turbines for the engines at present employed the coal consumption might be reduced to one and one-half pounds per indicated horse-power-hour, which would call for only 12,000,000 tons per year. The saving in coal was then computed to be 28,000,000 tons, which, at $1.75 per ton, would be $49,000,000. The cost of making the change was estimated at $250,000,000. If the power were to be delivered as electricity the cost of the change would be $300,000,000. The saving on the coal bill would amount to 19.6 per cent on the lower capital expenditure, and 16.3 per cent on the higher. In the latter case the incidental savings due to the highly available and convenient form of the power would more than compensate for the extra expenditures. In many cases the general reduction in working costs, which would result from the installation of more efficient apparatus, would amount to as much as the saving in coal. Means are now at the disposal of British consumers whereby power in bulk may be produced and distributed as cheaply as at certain of the more important water-power stations in Europe and America. Apart from the gains to the manufacturer who used, and the engineer who supplied, this power, there is a great economic value to the nation in the conservation of its coal resources; and this latter is of special importance in view of the steadily increasing demand for power per head of the population. This, if it be met by the old, wasteful system, will still further tax the coal resources. Under the new conditions it is probable that the rapidly increasing demand for power may be met by a diminishing coal bill.

PORTLAND, ORE., ELECTRICAL NOTES.

BY C. M. HYSKELL.

After a contest fought with great determination by both sides, the street committee of the city council of Portland has rejected the schedule of prices made up by the executive board of the council for use of the streets by electric light and power companies, and has recommended a schedule fixing the prices of franchises at about one-sixth the amounts demanded by the board. The street committee's recommendations in the matter are equivalent to their adoption by the city council, which is strongly Republican, while the mayor and his executive board are Democratic.

The board's schedule required applicants for franchises to agree to pay over to the city the following remuneration for use of streets: two per cent of the gross earnings of the company the first five years; three per cent the second five years; four per cent the third five years; five per cent for the remaining ten years of a twenty-five-year franchise. The city council committee cuts these rates to the following: one-half of one per cent the first five years; three-fourths of one per cent the next ten years; one per cent for the next ten years.

These rates will become the standard of charges by the city for electric franchises. Developments now under way promise a large increase of available electric power in the Willamette valley within the next twelve months. Three power companies—the Mount Hood Electric Company, the Cascade Electric Company and the Cascade Power Company—are applicants for franchises, and their applications gave rise to the agitation that has resulted in the city council's action. The three companies are developing water powers from the streams that head in the glaciers of Mount Hood, fifty miles from Portland, and will generate current aggregating about 100,000 horse-power, if the plans announced are consummated. The Mount Hood company, which has been financed with a capital of $1,000,000 by the Bank of America, a San Francisco institution, is receiving bids on equipment for the first of two plants it will construct on the Sandy river. The organizers have discovered a singular fact, proved by government records, that in a watershed of 500 square miles on Mount Hood at altitudes ranging from 3,000 to 7,000 feet, the annual precipitation is eighty-four inches, or double the annual precipitation in Portland. As the temperature at Government Camp, 6,000 feet high, averages from thirty-three to eighty-four degrees above zero, conditions are favorable the entire year for a steady supply of water. The rains of the fall, winter and spring months feed the streams, and after the snow melts in summer to the upper limits of timber line, there still remain the Big Sandy and Zig Zag glaciers, which furnish an abundance of water during July, August and September.

This water is to be used first by the Cascade Electric Company, near what is known as Tollgate, at an elevation of 7,000 feet, where three streams forming the Sandy river are flumed to a point where the water is dropped 200 feet, and about 20,000 horse-power is secured. Below this point the Mount Hood Electric and Cascade power companies use the water three times, securing an aggregate head of 850 feet, and producing about 80,000 horse-power.

At the Mount Hood company's plant No. 1, thirty miles from Portland, there is an available water supply of 600 second-feet, and it will be utilized under an effective head of 300 feet, giving a minimum of 17,000 horse-power. The development will consist of 5,000 horse-power units. With its reservoir capacity, the plant will, it is estimated, be depended upon for a reasonable peak-load period of 25,000 horse-power. Construction of the canal, which will be five miles long, is now well under way. The water will be discharged into a reservoir of about 100 acres.

After the water is discharged from the wheels of plant No. 1, it will be carried in a canal six miles to a large basin near the town of Bull Run, 320 feet above the stream. In the same basin, at this point, will also be emptied the waters of the Little Sandy river, through a three-mile flume. The available water here will be 800 second-feet, which with a 320-foot head will have a generating capacity continuously of 24,000 horse-power. The final development here will consist of six units of 5,000 horse-power each. This plant will be twenty-two miles from Portland.

The Cascade Power Company next takes the water and conducts it by canal and wood-stave pipe to a site five miles down the Sandy river, where with a volume of 1,000 second-feet and an effective head of 220 feet it will be finally dropped into water-wheels giving about 20,000 horse-power at the generators. This plant is sixteen miles from Portland. Its development will consist of five 5,000-horse-power units.

Plant No. 2 of the Mount Hood Electric Company, now under construction, will have equipment comprising six units having a hydraulic development of 5,000 horse-power each with a speed of 450 revolutions per minute, direct-connected, the alternators generating three-phase, sixty-cycle current at 2,200 volts, each having a normal capacity of 3,500 kilowatts. The transformers will be in banks of three, having a normal capacity of 5,000 kilowatts per bank, each bank thus providing for two generators. The current from all these plants will be transmitted over three independent transmission lines at a voltage of 40,000. The Mount Hood company is composed of prominent Portland business men, numbering about thirty, who avow the intention of making a radical cut in prices of electric light and power. Anticipating their action, the Portland General Electric has reduced its rates from a basis of twenty cents to fifteen cents per kilowatt-hour.

The Portland General Electric announces that it will expend $1,000,000 this year in construction of its Portland arc lighting system and in construction of a modern office building. At the annual meeting just held the following directors were elected: H. W. Goode, F. V. Holman, A. C. Bedford, Frederic B. Pratt, W. M. Ladd, J. C. Ainsworth, W. K. Smith, Sylvester Farrell, Charles H. Caufield, F. G. Sykes, S. G. Reed. The directors will reelect H. W. Goode president and S. G. Reed secretary and treasurer. During the last year the company has completed a steam plant with a capacity of 12,000 horse-power, doubling its former capacity, which was wholly derived from the falls of the Willamette river at Oregon City. By a bond issue of $10,000,000 the company has refunded its debt and provided for enlargements and improvements. The present coke-carbon arc-lighting system will be supplanted by magnetite arc lamps for street lighting, in which 1,200 lamps are required. The installation of the new lamps will require new apparatus at the power station, and a renewal and rearrangement of the lighting circuits. The alternating current used primarily will be changed to a direct current by means of mercury tube rectifiers, and new transformers will be installed. The company's architects are at work on plans for a five-story steel office building, the lower story of which will contain one of the most modern power stations on the Pacific coast. The building will occupy a prominent downtown corner, and large show windows around the two open sides will enable the public to view the operation of the machines. The machine room will be 100 × 80 feet and will be finished in white tile.

THREE-PHASE-SINGLE-PHASE TRANSFORMATION—A CORRECTION OF A MISAPPREHENSION.[1]

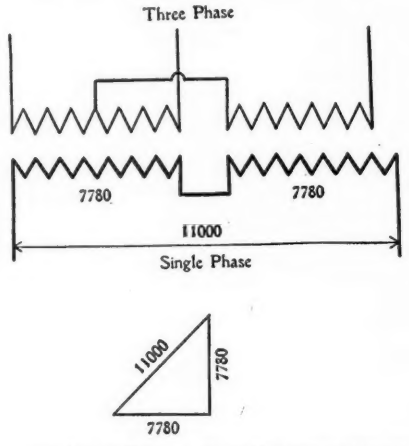
BY CHARLES F. STOTT.

"It is desired to take three-phase current from the power-house bus-bars and convert it to single-phase current without unduly unbalancing the three-phase system. A sketch of the transformer connections proposed is shown in Fig. 1. Certain engineers advise that this will produce unbalancing of the three-phase system. Why is this so? Is there a possible rearrangement of connections which would obviate this result?"

In connection with various methods, which are from time to time proposed for operating a single-phase circuit from a three-phase generator, there is a general principle which is universally applicable. In a normally operating symmetrical three-phase system the flow of energy is uniform. It is comparable mechanically to the continuous flow of energy through the instrumentality of a belt or from an engine where two or more cylinders with connecting rods are connected to a common shaft, their cranks being set at the usual angles. The single-phase system, on the other hand, has as its characteristic an intermittent flow of energy. At certain moments the energy is zero. It is therefore impossible to convert from three-phase to single-phase and continue the normal operation in both systems unless there be some provision for storage of energy, such, for example, as a rotating armature, which may be driven by a three-phase current and deliver single-phase current. The armature receives energy at a uniform rate and gives out energy at a periodically varying rate. The excess energy received during alternate intervals is stored in the form of mechanical energy in the armature; in the intermediate intervals it is delivered to the single-phase circuit. In this manner the average energy of the single-phase system is equal to the uniform energy of the polyphase system. Such a means of storing energy, however, is not found in ordinary transformers.

The foregoing consideration is a conclusive answer to the proposition that single-phase power can be taken by means of ordinary static transformers from a three-phase system without unbalance.

In the diagram representing the ordinary three-phase two-phase transformation by means of two transformers, the two secondary windings, which ordinarily deliver two-phase current, are in this case connected in series for supplying a single-phase circuit. The currents in the two windings must therefore be alike in phase instead of differing by ninety degrees, as in a normal two-phase circuit. The electromotive forces on the individual secondary coils still differ in phase by ninety degrees. The currents which would flow through resistances, connected respectively to the individual coils, would likewise differ in phase by ninety degrees. But, when a resistance is connected across the two coils in series the same current will flow through both coils and its phase will be midway between the phases of the currents which the coils would produce if acting independently. It follows, therefore, that the phase of the "single-phase current," which is delivered by the two secondary coils in series, lies between the phases of the electromotive forces, *i. e.*, the maximum value of the current lags behind the maximum value of the electromotive force in one of the coils and leads that on the other coil. Hence the resultant current is a lagging current in one transformer and a leading current in the other.



SINGLE-PHASE-THREE-PHASE TRANSFORMATION.

The current in a primary winding of a loaded transformer has its maximum and zero values at practically the same instant as the current in the secondary. In the transformer which has a tap from the middle of its primary winding the current in this winding is the resultant of two components; one is the primary current, which produces secondary current in this transformer, and the other is the current which is received from the other transformer. As this current divides and flows equally from the centre through the two halves of the winding in opposite directions around the core, it produces no effect upon the secondary. In normal three-phase two-phase transformation, the two components in each half of the winding differ in phase by ninety degrees. When, however, the final secondary circuits are connected in series, these two component currents are of one phase. The current which enters at the middle point of the primary divides and flows one-half in the same direction as the primary current and the other half in the opposite direction from the primary current in this winding. Hence the resultant current is found by direct addition in one-half and subtraction in the other half. The result is that the current in the three wires from the three-phase generator is single-phase current, one wire constitutes one side of the circuit and the other two wires carry the return current. The three-phase generator is, therefore, badly unbalanced.

[1] Electric Journal—January, 1906.

Long-Distance Wireless Telegraph Message.

The officials at the government wireless telegraph station at Cape Elizabeth, Me., state that they received, at 7.35 o'clock on the night of Monday, January 15, a wireless telegraph message from the dry-dock Dewey, which is now on its way to the Philippines. The message was sent by one of the tugs accompanying the dry-dock, and it stated that at the time of sending the dock was 2,226 miles off Cape Hatteras, and moving at four and one-half knots per hour. This location of the dry-dock would make the distance between the sending vessel and the receiving station more than 3,000 miles.

Electric Lighting at the New York Hippodrome.

The now universal use of electricity in theatres occasioned the following remarks by Thomas A. Edison, during a recent visit to "A Society Circus" at the New York Hippodrome.

"The great progress in the electric lighting of theatres, and more particularly the Hippodrome, is astonishing. Twenty-three years ago electricity was first used for lighting purposes and property effects in the Bijou Theatre, Boston. I personally installed the system. But never have I been in any theatre where the use of electricity is so extensive as at the Hippodrome. It is the greatest display I have ever witnessed, and from a superficial judgment the Hippodrome must consume enough electricity to supply a small-sized city. I understand from the records of the Edison company that it is the largest consumer in the city, the supply used being equal to that of any ten theatres in town. That electricity may be employed to encompass beautiful and artistic effects is illustrated in this production, especially in 'The Court of the Golden Fountains' and other scenes and stage settings."

A Review of Telephone Patents Issued in 1905.

(Concluded.)

By Edward E. Clement.

THE sixth heading includes nine patents for intercommunicating systems. These systems are necessarily somewhat alike in their general features, the differences being in detail only. All of them show the usual individual wires and common return, and all but one or two have common battery, which is now demanded even in interior systems without a switchboard.

The seventh and last group is that containing auxiliary devices and matters of detail. I subdivide this group into the following: meters or registers; composite systems; signal devices; toll devices; telephonic relays; induction coils; and miscellaneous details.

Taking these subdivisions in order, I find there were fourteen patents granted for meters or registers. Seven of these are the property of the Western Electric Company and cover different forms of mechanical recorders for counting the number of calls made by a subscriber. As a general rule only those calls are counted which result in a complete connection, and in almost all these cases provision is made for disabling the meter if the wanted subscriber does not answer. A significant feature is the general location of all meters at the central office. It is true that one patent was granted to the Gray Pay Station company, of Hartford, for a meter comprising a Veeder cyclometer register and a push-button to operate it, together with a gong struck by the same. This is intended to be located at the subscriber's station, the operator causing him to push the button before putting him through and knowing by the sound of the gong whether he has done so. It is true also that some of these subscribers' registers are simple and do not complicate the circuits, being in fact purely mechanical. Nevertheless, the tendency is strongly toward central office registers, and more than this it is toward centralization even in the central office. In a patent granted last July to a French engineer, and assigned to the Western Electric Company, a scheme is developed for having one register common to a considerable number of lines. The elements of this register are divided into tens and units groups, and each line is given control of its appropriate element in each group. Thus, a call by line No. 43 would control element No. 4 in the tens group and element No. 3 in the units group, to which it is appropriately connected. These two elements in operation then produce the number 43 on the tape or other record surface.

The other register patents for the year are directed to different schemes. One patent, to Yoder, of Toledo, is very interesting. It shows a set of registers at the central office which respond to the acts of the operators so as to record the times of answering calls and making connections. The claim is made that this gives the traffic department as well as the operating department valuable data, enabling the load to be properly distributed and stimulating the operators to constant exertion. In places where this and similar schemes have been employed I am assured the effect upon the service has been very marked.

Other patents of minor interest relate to watchmen's time recorders and the like worked over telephone circuits. There is a significance in such designs also that should not be overlooked. Every telephone system represents an investment which must necessarily be idle at least part of the time. There is a good demand for auxiliary devices which will utilize the idle circuits, and if possible some of the apparatus without interfering with its telephonic functions. Some expedients directed to this end are already familiar, the most important being the adaptation of long-distance telephone lines to superposed telegraph service. The production of satisfactory composite systems in city exchanges, however, is attended with many difficulties by reason of the already complex nature of the telephone signal apparatus, its sensitiveness and the necessity for keeping the talking circuit clear. Nevertheless, much work has been done in this direction and seven systems were patented during the year. A good example of these is the W. W. Dean system for unlocking safes at substations by means of combinations of different currents put upon the telephone lines at central at predetermined times. Other patents relate to fire-alarm devices applied to the ordinary telephone circuits and the like.

Among the patents for receiving and recording devices I may mention, in passing, two which were issued in May for improved forms of Poulsen telegraphones, employing a plurality of receiving magnets producing multiple magnetic traces on the same wire; the second patent showing also a complete machine outfit.

Fourteen patents were granted during the year for special forms of magneto-generators, relays, annunciators and other signal devices. Among these are several for hand generators fitted with commutators, useful in selective signaling, and two patents for the standard relay with bell-crank armature, of the Kellogg Switchboard and Supply Company. One of these is in the name of William Kaisling and the other, which has visible contacts, in the name of Manson. Both applications were filed some time ago, and both types have been redesigned by others since that time.

Among this group are found also two patents for pole changers used for producing alternate ringing currents. The original patent for such devices was taken out years ago and has now expired, hence all recent patents have their claims limited to features of improvement merely; but the tendency is quite noticeable to perfect and use pole changers in place of ringing generators, especially in small exchanges. The economies are very marked and it is understood that a perfect and complete outfit of this type for selective ringing will shortly be on the market.

Under the head of toll devices, I find six patents for the year, one to Dr. Kitsee, in Philadelphia, employing the old Hughes induction balance scheme, with a pair of coils at the subscriber's station and another in the operator's circuit at central, so she can tell if the right coin has been placed in the box. One or two of the other patents show devices for automatically signaling the deposit of the coin and for returning the same if the call is not answered. A design patent was issued to the Gray Telephone Pay Station Company, of Hartford, for a toll box in the shape of a shield, which is the official emblem of the independent telephone association. This company has had out already a toll box shaped like the blue bell and it evidently has an eye to the future.

The telephonic relay has been the subject of many dreams and by some engineers has been regarded as a useless toy, never to become a recognized element in standard systems. Nevertheless, it has received attention from distinguished minds and during the past year no less than nine relay patents have issued. Four

of these are of the usual light-weight variety, but the other five are worthy of serious notice. Two of them stand in the name of Mr. Peter Cooper Hewitt, whose mercury-vapor lamp seems to be a sort of Poo-Bah, filling many offices. One of his patents covers the means and the other the method, according to our present patent office practice, but the invention is the same in both. It depends upon the fact that the resistance of an enclosed vapor or gas-carrying current in an electric circuit varies inversely with the current. If a varying potential be applied to such a device as the mercury-vapor lamp, a variation of current will take place, and this will affect the entire circuit; and if the circuit is so arranged that the resistance of the lamp represents a considerable portion of the total circuit resistance, the variations in the circuit will be comparatively large. To take advantage of this, a source of current, a transmitter, a receiver and a mercury-vapor lamp are all included in series. It is stated that the lamp or tube may have a short gas or vapor path with such a cross-section that normal current will render it only faintly luminous. Changes in the transmitter, producing changes in the potential difference between the terminals of the lamp, produce thereby the comparatively large variations in current to which I have referred. I am not informed how far Mr. Hewitt's experiments have been carried, or whether the device is proved to be a commercial possibility.

The third relay patent of note was granted to Dr. W. W. Jacques, of Boston. Dr. Jacques took out a patent in 1904 for a distortionless circuit, familiarly called a ladder-circuit, and he called attention to the fact that while the attenuation on such a circuit 1,000 miles long may be to one one-hundred-and-fiftieth of the original intensity without preventing good commercial conversation, the attenuation on a 2,000-mile line is to one twenty-two-thousand-five-hundredth, which makes the waves so feeble that conversation is impossible. He therefore purposes to relay the waves at the end of the 1,000-mile line. He says that simple relays are of little practical use, because if the contacts are lightly adjusted so that considerable magnification is obtained the high-pitch waves are magnified out of all proportion to the low-pitch waves, and the speech becomes shrill and inarticulate. For the purpose of correcting this, he uses two relays, each consisting of a telephone receiver and a microphone, the telephone receiver of the second being in circuit with the microphone of the first, the one relay having its parts delicately constructed and its normal pressure exceedingly light, while the other relay has its parts more massive and its normal pressure heavier. The first relay magnifies but at the same time distorts the sound-waves, while the second serves to correct the distortion of the first. Each one multiplies the magnification, and their errors neutralize each other. He calls the pair a "compound relay," by analogy to a compound microscope.

The last two relay patents are in the name of Mr. Herbert E. Shreeve, assignor to the American Telephone and Telegraph Company. The two patents relate to the same general type of instrument, one being more specific than the other and showing a specially wound induction coil. In this the invention is stated as residing in the combination of the through lines with a relay having a repeating induction coil of small mutual inductance or such a coil having its primary winding bridged between the main current conductors and its secondary joined up in circuit with the electromagnetic receiver of the relay. The coil has an iron core with a primary winding connected over the two halves differentially or in magnetically opposed half-windings, while the secondary is correspondingly arranged so that the currents induced in its halves shall coincide in direction.

Such a device as this can be used upon composite circuits, the coil having a very low efficiency for the telegraphic currents, which are of relatively low frequency, while its efficiency for high-frequency telephone currents is only slightly reduced. The structure of the relay includes an iron shell, which may be slit to prevent eddy currents, and fitted with discs so as to have a large radiating surface for heat, permitting the use of a large current; a coil with an adjustable core, and a White transmitter button fixed in the shell with a small light iron stud fastened to its front electrode and extending into the coil after the fashion of a plunger. The instrument is said to have been tried commercially and to be very efficient.

With distortionless circuits in unit length of 1,000 miles, and compound distortionless relays connecting these unit lengths, the possibility of greatly extended ranges of transmission becomes greater; and it would seem that such conditions as difference in time, and hence in the business day, would in the future have more to do with determining the limit than mere physical factors.

There were three patents for induction coils during the year, of which the Campbell coils alone need mention. The patent is assigned to the American Telephone and Telegraph Company, and the invention comprises a core with two windings, a conducting shield for each winding, and an outside conducting shield surrounding both windings and their shields. The object is to balance the circuit in which the coil is used. The windings are shielded from each other and also from external disturbances.

The last subdivision and the last patents to be noticed are those for details, which I will not go into specifically, except as an example of the care with which even detail work is now being done in the art, to call attention to the Gherky patent, 798,031, for a conduit stopper. The device comprises an iron spindle with a bail at each end, and a pair of more or less flexible discs secured under the bails. The purpose is to replace the ordinary unsatisfactory wooden plugs for stopping the ends of ducts in the trench. The discs are a little larger than the bore of the duct, and when the device is thrust in they dish slightly. An iron hook is used to pull the plug out and the dished discs then bring all the mud, silt, etc., along with them. The device has been largely used in Philadelphia and New York, it is said.

The other detail patents cover insulators, binding-posts, strap cable hangers, and in one case a hanger for attaching a portable telephone to the door of a fire-alarm box, this being due to Mr. A. G. Davis, of the Viaduct Company in Baltimore. When detached the telephone is folded up in its own casing, which is made of leather and fitted with a clasp or lock.

Patents alone scarcely form a sufficient foundation upon which to base prognostications, but taken with the general signs of the times they enable us to recognize some of the tendencies now existing. In closing this review a few remarks upon these tendencies are appropriate. The telephone service of the future will undoubtedly be on a message-rate basis or a combination of message rate and time rate. The tendency is to use meters at the central office exclusively, and this will undoubtedly be standard practice. In addition to the call-registering devices, there will be in every up-to-date office equipment means for registering the performance of the connective agencies, whether human or mechanical. It would seem that the same central office registers may record both the calls and the operators' time.

Toll station devices will presumably not be much changed, except in matters of detail. Subscribers' apparatus, generally, is

not liable to change to any great degree, unless it be in the addition of some sort of sending device, which must be separate from the instrument itself for automatic work.

Line and cable designs are not likely to change for some time, although practical solutions for the cable problem are being looked for with eagerness by the operating people. It is likely that a greater subdivision in systems will raise their efficiency by increasing the flexibility in use of the cables and their component conductors. In other words, instead of having a separate pair of wires allotted to each station or each group of four stations, means will be introduced for giving calling subscribers access to a considerable number of lines for the purpose of selecting idle pairs as they are needed. This will involve the establishment of branch exchanges or centres of distribution, which must be automatic in operation and so simple in their equipment that their cost of maintenance will be small compared to the saving effected. I believe there is a strong tendency toward the establishment of automatic branch exchanges, and that this will grow stronger among the independent as well as among the Bell engineers during the coming year.

There is not likely to be any substantial change in methods of operating. Schemes for the automatic distribution of incoming calls among idle operators will not be generally accepted until they have been thoroughly demonstrated. Many engineers believe that they introduce needless complication, that with a proper use of the intermediate frame (and even in some cases without this) the maximum amount of equipment is required for the maximum load and that variations among the operators are very small during the busy hour.

There will be, as time passes, a growth of the present tendency to combine the best features of manual and automatic apparatus wherever possible. The best manual equipment already contains so many features which may be called automatic, and a perfected form of automatic equipment must contain so many features taken from the manual, that in the near future there will be no sharp line between them and it will be possible to standardize circuits through any desired combination.

I do not believe that the human operator will ever be entirely eliminated for the reason that some classes of business, such as emergency calls, can be handled by operators better than in any other way. The operator's work, however, will be reduced to an absolute minimum and that very soon.

With regard to the patent situation, there are few very broad claims which now call for consideration. The distortionless circuit, as well as the relay circuit, seems to be getting pretty well covered, but it is unlikely that the inventor has said his last word on the subject.

Space telephony, so-called, is still a thing of the future, and with regard to the patents that have been issued it may safely be assumed that the systems they show, and their claims, rest upon mathematical deductions and hypotheses only, like the cable designs, without practical demonstration.

BOOK REVIEWS.

"Gas, Gasoline and Oil Engines, Including Producer-Gas Plants." Fifteenth Edition. Gardner D. Hiscox. New York. The Norman W. Henley Publishing Company. Cloth. 442 pages. 6 by 9 inches. 351 engravings. Supplied by the ELECTRICAL REVIEW at $2.50.

But little need be said about the fifteenth edition of Mr. Hiscox's book, except to note that it has been entirely rewritten and is in all respects a new work. It takes up the theory of the internal combustion engine and its construction, going into some detail in the latter. The book includes a list of United States patents pertaining to the subject issued up to the present time and a valuable chapter on the rules and regulations of the Board of Fire Underwriters with regard to the installation and management of gasoline motors. It takes up also the subject of producer-gas and methods of making it. The volume forms a very complete treatise on the internal combustion engine.

"Synchronous and Other Multiple Telegraphs." Albert Cushing Crehore. New York. McGraw Publishing Company. Cloth. 124 pages. 6¼ by 9½ inches. Illustrations and working diagrams. Supplied by the ELECTRICAL REVIEW at $2.

Dr. Crehore has been interested in the newer methods of telegraphy for some time, and he presents here a valuable treatise on certain of these plans. His work is divided into three parts, the first being devoted to the general subject of obtaining independent telegraph circuits by means of the simultaneous use of direct and alternating currents on the same line. The results presented are not merely theoretical deductions, but have been verified experimentally. The second part of the book deals with methods of obtaining synchronous operation of apparatus at two widely separated stations. The third part of the book is a discussion of synchronous telegraph systems. At the present time a good deal of interest is shown in improved methods of telegraphy, so that Dr. Crehore's treatise is timely.

"Physics." Charles Riborg Mann and George Ransom Twiss. Chicago. Scott, Foresman & Company. Cloth. 450 pages. 5½ by 8 inches. 240 illustrations. Supplied by the ELECTRICAL REVIEW at $1.25.

This is a text-book of high school grade, written by a high school instructor and a university professor. The fullness of the knowledge of the authors has resulted in a book which is accurate, modern and with its parts well coordinated. Inspired by some passages in G. Stanley Hall's "Adolescence," and conscious of an inadequacy of present prevalent methods of instruction in physics, the authors have endeavored to write a book which will arouse the student's interest, will develop in him the scientific habit of thought and will give him an historical glimpse of some parts of the subject. The book promises well the accomplishment of these purposes. One thing of interest to electrical engineers is the recognition on the part of the authors that the principles of force, motion and energy are better illustrated by the different phases of vehicular transportation than by falling bodies, which fall so fast that they needs must be viewed through an Atwood's machine.

"The Production of Aluminum and Its Industrial Use." Adolphe Minet. Translated, with additions, by Leonard Waldo. New York. John Wiley & Sons. Cloth. 266 pages. 5 by 7½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.50.

The production of aluminum was one of the most striking metallurgical achievements of the latter part of the last century. The problem is an old one and had been attacked frequently but never solved satisfactorily from a commercial aspect until the advent of the electric furnace. In this book M. Minet describes all the important methods of producing aluminum that have been devised, including the chemical as well as the electrochemical. There are many of these, though to-day but little is heard of any except two or three. These naturally receive more attention than do the others. The book contains also a discussion of the use of aluminum in commerce and of aluminum alloys. It must be said that the glowing accounts of the properties of aluminum, which were published so widely when this metal was first made available, were considerably overdrawn, but for purposes requiring a strong, light material, its alloys are available, while the pure metal itself has many uses which at that time were hardly dreamed of. A valuable addition to the book is the appendix by Dr. Waldo, which deals with the development of this industry in the United States. Some useful tables of the properties of aluminum are included and there is a convenient bibliography of works on this metal.

MOTOR-DRIVE AND MACHINE SHOP ECONOMY.

BY E. R. DOUGLAS.

A few years ago the question of motor driving was considered entirely on the basis of saving in power. Much ingenuity was spent in computing power losses in line shafting, belts and countershafts and in determining the precise points where saving in power was offset by increased investment charges. It is undeniable that the loss in transmitting power electrically, except over short distances, is less than with mechanical transmission, especially as the amounts of power become large; and, when the driven units are few and large, the first cost of motors and wiring may be no greater than the cost of shafting and hangers. The motor-drive problem then becomes comparatively simple.

But with greater subdivision and smaller absorbing units the first cost is increased enormously. Not only are small motors relatively more expensive than large ones, but the number of motors standing idle or running lightly loaded at any time is greater. The total motor capacity for the plant is therefore much increased, even three, four, or five times. For these reasons applications of motors to the driving of factories were at first confined to the class known as "group" driving, in which a few good-sized motors drive independent short lengths of line shafting to each of which a group of machines is connected by means of belts and countershafts.

The driving of machines by individual motors came slowly, some of the first applications being in the equipment of printing establishments, where the convenience, cleanliness and ease of control of such drives were early appreciated.

In machine shops, to which this paper has principal reference, the first applications were on tools under traveling cranes where the absence of belts and overhead work was an obvious advantage. It was not until this stage had been reached that the principal advantages of motor drive even began to be apparent. Those first disclosed were:

(*a*) Clear overhead room for crane service.

(*b*) Better light and ventilation, since unobstructed by belts and shafting.

(*c*) Absence of dirt and grease thrown about by moving belts.

(*d*) Reduced fire risk from dusty, oily moving belts.

(*e*) Cost of repairs and up-keep on hanger-boxes, belts and countershafts eliminated.

(*f*) Greater flexibility of shop arrangement, location of machines where most convenient without reference to lines of shafting; possibility of rearrangement to suit changed conditions.

(*g*) Convenience of motors for driving auxiliaries, moving heavy parts of machines and operating extra cutting tools on special jobs.

(*h*) Entire absence of power loss when machines are not in operation.

As these became apparent individual drive increased in favor and was applied on smaller and less important machines, and the advantages were generally found to have justified such action.

It will be seen that the argument for motor driving has tended, from its first position where cost of power was alone considered, toward one in which comfort, convenience and general economy are more important. There is a dollars and cents argument for this. Men work better and do more when they are comfortable, when light and ventilation are good. Convenience means minimizing of delay and more rapid production. There is often a greater saving from the entire elimination of small losses than from trifling reductions on the larger items of expense.

But with all these advantages motor driving of factories proceeded for a number of years at only a moderate pace. The electrical companies worked for what they got and were often met with apathy or even determined opposition. It required a combination of two great improvements, directly affecting production, to bring about a change. These were the introduction of high-speed steel for cutting tools and the development of commercially practical variable-speed motors. With these came an appreciation of the importance of the labor element in manufacturing operations and certain carefully worked out systems for determining that and other elements of cost. To show the importance of the labor element there follows an analysis of the shop costs of an article manufactured under two differing sets of conditions. While the cases are hypothetical they are also typical.

TABLE I.—TOTAL SHOP COST.

(*a*)	Material	$0.50	$0.50
(*b*)	Direct labor	0.30	0.273
(*c*)	Indirect labor	0.10	0.091
(*d*)	Power	0.02	0.02
(*e*)	Supplies, repairs, maintenance	0.03	0.027
(*f*)	Interest and depreciation on plant	0.04	0.036
g)	Insurance, taxes, etc.	0.01	0.009
		$1.00	$0.956

The subdivision might be made more complete, but there would be no advantage for the present discussion.

In the first column the figures correspond, we will assume, to conditions of manufacture in which electrical power is not employed. It will be seen that the cost of power is but two per cent of the total cost of manufacture, while the cost of direct labor is thirty per cent. Anything which would decrease the labor cost per article by a given percentage would cheapen the article a great deal more than a similar percentage reduction in the cost for power. Such reduction in labor cost might come either from the employment of a cheaper grade of labor or through greater rapidity of production, or both.

An inspection of this table shows that increase in the rapidity of production, meaning increased output from the same plant and laboring force, affects not only the direct labor, item (*b*), but also generally items (*c*), (*e*), (*f*) and (*g*), since, with an identical expenditure for those items, the output is assumed to be increased. Items (*a*) and (*d*) may or may not be affected. For simplicity assume that they remain the same.

If, then, with the same plant and labor the output of the article in question be increased ten per cent by some improvement, items (*b*), (*c*), (*e*), (*f*) and (*g*) are reduced one-eleventh. These conditions are shown in the second column of the table. The total cost of the article is thereby reduced from one dollar to 95.6 cents, a gain of over four cents, or more than double the whole cost of power.

The apportionment of shop costs among the different items of table 1 would vary considerably among establishments working on different lines. Particularly would variations in the relative amounts for material and labor be met. The general character of the result obtained by decrease in the labor element would not be greatly changed thereby.

One of the important improvements affecting the use of motor drive has been stated as the introduction of "high-speed" tool steels. Without going into unnecessary details the peculiarities of these steels depend both on their chemical composition and on a peculiar heat treatment. Their introduction caused great changes in machine shop practice, as they permitted increases in cutting speeds of 100 to 500 per cent. Where fifteen to thirty feet per minute had been every-day values for steel, speeds now range from sixty to 180 feet per minute, with a corresponding gain in rapidity of production.

While this is accompanied by an in-

crease in the power required to drive the tools, the total cost of power to complete a given job will not be greatly affected, as, although the power requirement is greater, the time required is less.

In the upheaval caused by these steels much that was obsolete beside cutting speeds was brought to light. When it was attempted to use such steels at their highest speeds on machine tools of ordinary designs, those tools speedily developed structural weaknesses, made apparent by breaking down or by excessive vibration. The general line of metal-working machinery has had to be largely redesigned, not only made heavier, but changed entirely in important details in order that the machinist may avail himself of the highest speeds now possible.

It would also seem that even the steels formerly standard were not, except in a very few cases, used up to their limit of capacity, this owing to lack of knowledge on the part of the workman as to what he could do, lack of attention on the part of the foreman, if he had the knowledge, and general indifference to the details of rapid production. The advent of the new steels called attention to this laxness and to the need of taking complete advantage of the new situation. If a tool steel, which, under given conditions could cut at 100 feet a minute, were actually used at only eighty feet, the time of machining would thereby be increased twenty-five per cent, a margin well worth saving. As, in many cases, the machine operator is not skilled in judging cutting speeds accurately, it has become necessary to have these speeds determined for him by some one else, as by a speed foreman.

When such a speed foreman attempts to specify the most advantageous cutting speed for a given job on a machine tool of the ordinary belt-driven type, he often finds that the speed he wants is not obtainable. Take, for instance, the usual engine lathe. The steps given by the cones and back gears very often differ from each other by as much as fifty or sixty per cent. If 100 feet per minute were desired on a job it might be found that the nearest speeds the lathe would give would be seventy-five and 120 feet per minute. The latter would probably be so high as to require regrinding the cutting tool in too short a time. The former would mean an increase of thirty-three per cent in the time of machining. The lower speed has been the alternative necessarily chosen in many such instances, but the cause is apparent of the demand for a closer gradation of speed steps.

Another difficulty in the way of rapid production with belt-driven tools comes from the inconvenience of changing speeds with the means usually provided. Many jobs of lathe work, for instance, require the finishing of several surfaces of different diameters, or it may be the facing of surfaces, the outer and inner diameters of which are quite different. To do such jobs in the quickest time the most advantageous cutting speeds must be used on each one of the different diameters, or the speeds must be changed often during the facing so as to keep the cutting speed as near as possible to its maximum. To do this requires that the workman shift the belt and possibly change the back gear. The former may be done while the machine is in motion, but for the latter it must be shut down temporarily. Most men will not, unless they are pushed, take the trouble to make as frequent changes in speed as economy demands. They allow the machine to run on a slow speed through a considerable range of work. If it were very easy to change speed very much less stimulus would be needed to keep them up to proper standard.

Having grasped the conditions preceding the advent of the variable-speed motor, and particularly the limitations of the belt-driven tool, it is necessary to consider the methods of proper speed control and the results they produce.

The commercially successful systems of motor-speed control may be grouped under three classes: two-wire systems, three-wire systems and four-wire systems.

The two-wire systems make use of a single voltage and a motor capable of large speed variations by field regulation. Until recently it was not found practical to make a variation in speed of more than thirty per cent in this manner, as the tendency of the motor to spark became excessive at the higher speeds and weak fields. Improvements in motors now permit of speed ranges of 2:1 or 3:1, and in the case of certain very special motors as much as 6:1, with fairly satisfactory results. The sizes of motors required for these large ranges become, however, very great as compared with the size of constant-speed motors of the same output, or even as compared with variable-speed motors on the three or four-wire systems. The two-wire system is one, nevertheless, of great promise for situations where the others are not deemed advisable.

The most common three-wire system makes use of 230 volts between mains and 115 volts between each main and neutral. This gives two speeds directly on the voltages. The increase by field regulation necessary to bridge the gap between them is nearly 100 per cent and the same increase is usually made above the 230-volt speed as well. The total range then becomes 4:1. The three-wire system is also used with uneven voltages, as, for instance, seventy-seven and 153, respectively, between the neutral and the outside wires, the main voltage being 230. Then 100 per cent increase by field regulation is necessary above seventy-seven volts and fifty per cent above 153 volts. If 100 per cent be used above 230 volts, a 6:1 range is obtained. With fifty per cent above 230 volts the range becomes 4.5:1.

When four wires are employed the system becomes technically known as the "multiple voltage" system. Call the wires *a, b, c, d.* The voltages between these wires in the order named may be 60, 80, 110, giving a total voltage between *a* and *d* of 250 volts. Voltages may also be obtained between wires *ac* and *bd*, making the total series as given in table 2. The ratios of these voltages to each other and to the maximum are given. The attempt has been made to obtain a geometrical series and it is sufficiently near to that for practical purposes.

TABLE II.—GEOMETRICAL VOLTAGES.

Wires.	Volts.	Ratios.	Ratios to 250 Volts.
ab	60	....	0.24
bc	80	1.38	0.32
cd	110	1.37	0.44
ac	140	1.27	0.56
bd	190	1.36	0.76
ad	250	1.32	1.0

If the voltages between wires *a, b, c,* and *d* may be 40, 120, 80, the total series of voltages in this case is given in table 3.

The arithmetical differences and the ratio to the maximum voltage is also given. The system here is arithmetical:

TABLE III.—ARITHMETICAL VOLTAGES.

Wires.	Volts.	Differences.	Ratios to 240 Volts.
ab	40	..	0.166
cd	80	40	0.333
bc	120	40	0.5
ac	160	40	0.666
bd	200	40	0.833
ad	240	40	1.0

On either of these systems field regulation is used to obtain intermediate speeds between the voltages and additional speeds above the highest. By either system large ranges, even as high as 10:1, can be covered in the motor with a minimum of motor capacity. The wisdom of obtaining such wide ranges as 4, 6, or 10:1 on any system, entirely in the motor at full power, is doubtful. Practice seems to indicate that since a number of me-

chanical changes to multiply the motor's range are required in the majority of cases of tool equipment, the most economical plan will make use of a motor whose average working range is not over 3:1, with the two, three or four changes of gearing which may be necessary in connection with it.

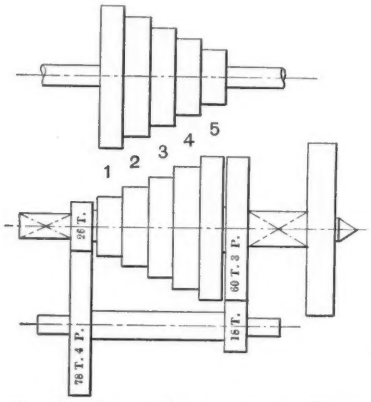


FIG. 1.—LATHE EQUIPPED WITH BELT DRIVE.

As an illustration the benefits resulting from the motor equipment of an ordinary thirty inches back-geared lathe can advantageously be considered. The speed requirements of such a lathe are:

First, to cover the range in diameters of work which may be done on the lathe, which may be from the smallest up to thirty inches, and,

Second, to cover a range in cutting speeds required for different kinds of cuts and for materials of different hardnesses which may be worked on the lathe.

In passing, a convenient formula may be given:

$$HP = VSK$$

where HP is the power required, V is the amount of metal removed in cubic inches per minute, S the cutting speed in feet per minute and K a constant depending on the material. K varies for cast iron from 0.25 to 0.4, for steel from 0.4 to 1. To the horse-power at the tool must be added the power to overcome the friction of the machine. This can be estimated only from experience. It may be stated that the constants given, while applicable to cutting tools similar to those used in lathes and planers, do not apply to milling cutters where the rubbing friction between the tool and the surface cut increases the power requirement greatly.

TABLE FOR FIG. 1.

Belt on cone step.....	1	2	3	4	5
Spindle speed — Back-geared.....	7	11	17	28	44
Spindle speed—Direct..	70	110	170	280	440

Suppose that, on the thirty-inch lathe to be considered, 120 feet per minute be the maximum allowable for soft machine steel at finishing cuts and that for roughing cuts sixty feet per minute is the fastest that can be used.

There are generally required not only the maximum cutting speeds, but also lower speeds for occasional jobs for which the power requirements will also be lower. It is convenient to have speeds down to thirty feet per minute, making the range thus far obtained 120 to 30 feet per minute, or 4:1.

The maximum speed of the lathe is generally limited by mechanical difficulties, due to vibration and heating of bearings; 500 revolutions per minute may be taken as this value. This speed is chiefly useful for polishing, but corresponds to 120 feet per minute on about nine inches diameter, and could be used for that. A diameter as small as this, however, would not very often be put on such a large lathe.

The other extreme of the diameter range is the requirement of 120 feet per minute on thirty inches diameter. This corresponds to 15.3 revolutions per minute. The speed range to cover variations of diameter is therefore from 500 to 15.3 revolutions per minute or about 33.1. The total range would be the product of the two, namely, four times thirty-three, or 133:1. The maximum speed being 500, the minimum would then be about four revolutions per minute.

Now let us see how well the original belted lathe meets these requirements. Fig. 1 and the table accompanying it show the details of the belt-driven equipment and the speeds which may be obtained from it. This represents fairly accurately the equipment usual on such a lathe. The maximum speed obtained is 440 revolutioins per minute. The minimum is seven revolutions per minute. The total number of speeds is ten. The range is therefore limited slightly on the upper end and considerably on the lower. The slowest speed, seven revolutions per minute, actually corresponds to fifty-five feet per minute on thirty inches diameter.

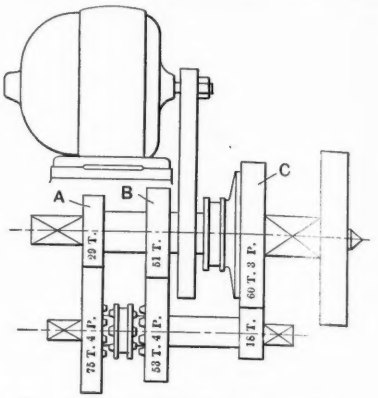


FIG. 2.—LATHE EQUIPPED WITH MOTOR DRIVE.

The method of equipping this lathe for motor drive is shown in Fig. 2 and the speeds are as in the table accompanying it. The system of driving is multiple voltage, already described. The motor is one which at normal speed and voltage gives ten horse-power. The controller is one giving, with the motor, twenty-two speeds from eighty-five revolutions per minute to 1,200 revolutions per minute, the horse-power varying from 1.6 to ten through this range, as shown in the table. The single back-gear of the belted equipment has been replaced by a double back-

TABLE FOR FIG. 2.

Voltage.	Controller.	Per Cent Field.	Motor Speed.	Motor Power.	Spindle Speed.		
					A	B	C
	1	0	85		4.1	10.2	35
40	2	30	110	1.6	5.3	13.2	46
	3	70	145		7.0	17.4	60
	4	0	225		10.9	27.0	94
	5	10	250		12.1	30.1	104
80	6	20	270	4.0	13.0	32.5	112
	7	30	290		14.0	35.0	121
	8	45	325		15.7	39.1	135
	9	0	390		18.8	47.0	162
120	10	10	430	6.0	20.8	51.7	179
	11	20	470		22.8	56.6	195
	12	30	510		24.6	61.6	212
	13	0	540		25.6	63.9	220
160	14	10	585	7.5	28.3	70.8	243
	15	20	635		30.6	76.5	264
	16	0	670		32.3	80.8	278
200	17	10	740	9.0	35.8	89.1	308
	18	0	825	10.0	39.9	99.2	343
	19	10	910	10.0	44.0	109.0	378
240	20	20	990	10.0	47.0	117.0	411
	21	30	1,070	9 0	51.6	129.0	446
	22	45	1,200	7.5	58.0	145.0	500

gear and the direct speed is for convenience controlled by a friction clutch instead of by the usual latch pin. The two back-geared speeds are controlled also by a clutch. The slowest speed will be referred to as gear-run A, the intermediate speed as gear-run B and the fastest or direct speed as C. The clutches are of such a nature that change may be made from one to another of these speeds while the lathe is in motion. The ratios of speeds between these different runs of gearing are so made that with the motor running at 1,200 revolutions per minute the spindle speed on gear A is fifty-eight revolutions per minute, on gear B is 145 revolutions per minute and on C is 500 revolutions per minute. The other speeds obtained by the controller on each run of gearing are set down in the table. It will be seen that starting with the slowest speed, position 1 on gear A, the series is continuous to position 22, fifty-eight revolutions per minute. The next position of the series begins on gear B at position 13, 63.9 revolutions per minute, and extends to position 22 on that gear 145 revolutions per minute. The third portion of the series, on gear C, begins on position 9, 163 revolutions per minute, and extends to position 22, 500 revolutions per minute, making a complete range of 4.1 : 500. The object of this choice of gear ratios and of the points at which the positions of the series start is to provide, on the different portions of the range of work which the lathe can swing, the amounts of power required on those portions with the most economical use of the motor's capacity. From position 4, on gear A, to position 8, four horse-power is obtained; from position 9 to 12, six horse-power; from position 13 on gear A to 15 on gear B, at least seven and one-half horse-power is everywhere obtainable. From here to position 21 ten horse-power is obtainable, and from 22 on gear B to 22 on gear C, everywhere at least six horse-power can be obtained. These facts are shown diagrammatically in Figs. 3 and 4, which show the horse-power with each diameter of swing at cutting speeds of approximately sixty feet and 120 feet per minute, respectively.

We may now consider, as a practical example, the time required for taking certain roughing and finishing cuts from a shaft with coupling end, as shown in Fig. 5. The forging is supposed to come rough-turned, leaving one-sixteenth-inch of metal to come off. The cylindrical parts B, D, F and H are to be rough-turned to leave one-sixty-fourth-inch for grinding. The faces and shoulders A, C, E and G, are to be rough-turned and then finished, working out the fillets. Face I is to be rough-turned only, the finishing cut being taken after keyseating and grinding.

The centres must be trued up before work can be done.

With the tool steel in use it is found that a roughing cut of three-sixty-fourths-inch depth and one-eighth-inch feed can be taken at sixty feet per minute, while the finishing cuts on the facing work are at one-quarter-inch feed and 120 feet per minute.

In the table accompanying Fig. 5 are compared the times required for carrying out the different operations to finish the shaft under ideal and under practical conditions. This table is condensed from a much more elaborate one in which each successive operation is considered in its turn and the time required for it is allotted.

This ideal condition assumed in column 2 is that the exact speed desired on any part can be obtained instantly. The total time required is then 181.5 minutes.

Columns 3 to 7 result when doing the work on the belted lathe shown in Fig. 1.

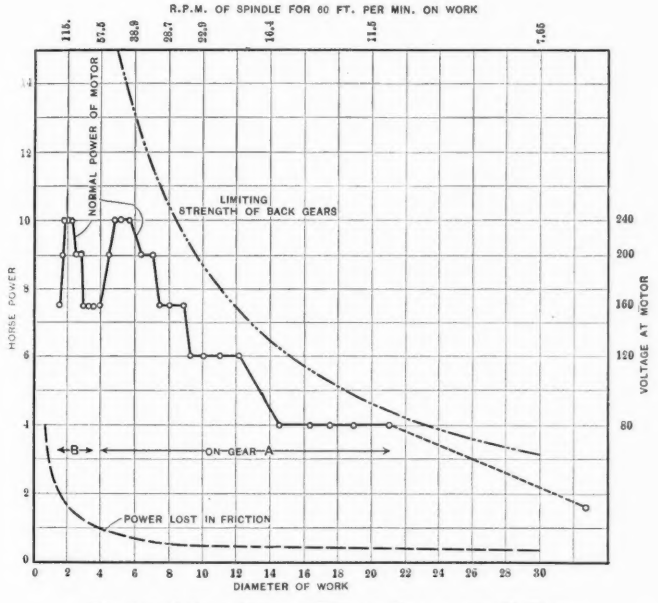


FIG. 3.—30-INCH LATHE—POWER CHART FOR 60 FEET PER MINUTE.

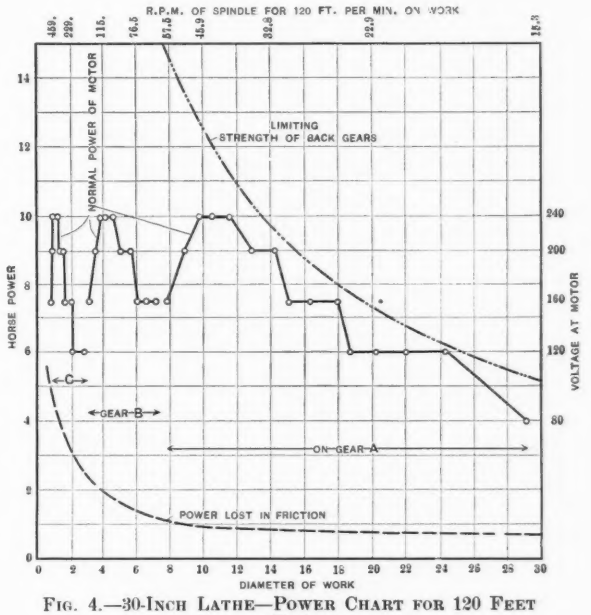


FIG. 4.—30-INCH LATHE—POWER CHART FOR 120 FEET PER MINUTE.

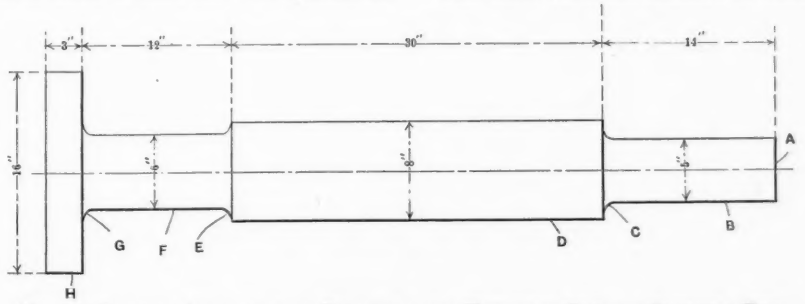


FIG. 5.—GRAPHIC ARRANGEMENT ROUGHING AND FINISHING CUTS ON COUPLING END.

In column 3 it is assumed that for each different operation the speed used is that nearest the ideal one. This requires twelve changes of speed, taking all together thirty minutes to shift the belts and back gears, or an average of two and one-half minutes per shift. The time required in turning is but little longer than that for changing speed.

In column 4 fewer changes of speed have been made, many of the shorter turning operations being done at slow speed rather than take the time to make shifts. While the time for turning has been somewhat increased the time for setting speeds has been diminished, giving an actual net reduction in total time.

In column 5 are set forth the results obtained when the number of speeds used with some favor is shown by the time set down in column 7, which is taken from actual practice.

In column 8 are shown the results obtained with a variable speed-motor drive. The time required for setting speeds when the lathe is so equipped is so slight that every change in speed called for by the ideal conditions may be made with advantage, and while the total time for making these changes is but 2.4 minutes the time required for the actual turning is but one minute greater than under ideal conditions.

The ratio which each of these total times bears to the ideal is also shown in the table, as well as the shop cost under each condition, assuming the labor to be worth forty-five cents per hour and the

TABLE FOR FIG. 5.

1	2	3	4	5	6	7	8
Time Required for Operation.	Ideal.	Belted.					Motor Driven.
		All Speed Changes.	Best Time.	Probable Time.	Ordinary.	Bad.	
	Time Given in Minutes.						
Setting up, centering	75.0	75.0	75.0	75.0	109.5	...	75.0
Setting tools	34.0	34.0	34.0	34.0	42.5	...	34.0
No. of speed changes	(13)	(12)	(4)	(2)	(2)	...	(13)
Setting speeds	0	30.0	10.0	6.0	7.5	...	2.4
Turning	22.5	31.9	36.7	43.7	67.5	...	23.5
Gauging	50.0	50.0	50.0	50.0	62.0	...	50.0
Total time, minutes	181.5	220.9	205.7	208.7	289.0	...	184.9
Per cent of ideal time	100%	122%	113%	115%	159%	264%	102%
Total time, hours	3.03	3.69	3.43	3.48	4.82	8	3.08
Cost, at 45 cents per hour	$1.36	$1.66	$1.54	$1.57	$2.17	$3.60	$1.39
Burden, at 90 per cent	$1.22	$1.49	$1.29	$1.41	$1.95	$3.24	$1.25
Total labor cost	$2.58	$3.15	$2.83	$2.98	$4.12	$6.84	$2.64
Could be saved by motor drive	.....	.....	$0.19	$0.34	$1.46	$4.20	...
Saving in per cent of actual cost	.....	.....	6.7%	11.4%	35.4%	61.5%	...

on the job, which were twelve in column 3 and four in column 4, are reduced to two. Even here but three minutes longer is required for the job than under the best conditions, as shown in Fig. 1.

Having discovered by experience the fact brought out by comparison of columns 3, 4 and 5 that on a belted lathe too close attention to speeds may mean loss instead of gain in time, it need scarcely cause wonder that the workman leans the other way.

Being educated, if at all, to use no more changes of speed than necessary, it is but a step to use slow speeds all through. Column 6 shows the results obtained by using but two changes of speed, each of them being one speed slower than the corresponding ones in column 5. It would indeed be an unusual condition which would spur the workmen to better results than this.

That even column 6 must be considered burden to cover shop expenses to be ninety per cent of the labor. The saving by use of motor-drive is given in the last line of the table, and especially in comparison with the conditions shown in columns 6 and 7 is seen to be considerable.

Of course it must not be assumed that the mere installation of a motor-drive on a machine-tool will lead to the full results shown here. Pains must at the same time be taken to insure that it will be properly used.

The Award of the John Fritz Medal.

The second award of the John Fritz medal has been made to George Westinghouse. This medal was established by the professional associates and friends of John Fritz, of Bethlehem, Pa., on August 21, 1902, the occasion of his eightieth birthday. The medal is to perpetuate the memory of his achievements in industrial progress.

Consolidation of Ohio and Indiana Railway Associations.

The Central Electric Railway Association has been formed by the merger of the Ohio and Indiana Interurban Railway associations. A session was held at the Algonquin Hotel, Dayton, Ohio, on Thursday morning, January 25. This meeting was continued during the afternoon, when officers were elected as follows:

President—E. C. Spring, Dayton, Covington & Piqua Railway.

Vice-Presidents—C. L. Henry, Indianapolis & Cincinnati Railway; F. D. Carpenter, Western Ohio Railway.

Secretary—J. H. Merrill, of Lima.

Treasurer—J. H. Milholland, Indianapolis.

Following the election of officers, J. V. E. Titus, president of the Garton-Daniels Company, Keokuk, read a paper on "Lightning Arrester Protection." The reading of this paper was followed by a general discussion.

On Thursday evening a banquet was served at the Algonquin Hotel, the programme of speakers including Judge C. J. Reilly, Detroit, Mich.; Mayor Snyder, Dayton; W. K. Schoepf, Cincinnati; W. Caryl Ely, Buffalo, N. Y., president of the American Street and Interurban Railway Association; B. V. Swenson, secretary and treasurer of the national association; C. L. Henry, H. W. Blake, F. S. Kenfield, J. S. McMahon, Gen. W. P. Orr, Arthur W. Brady, Edward Hanley, H. P. Clegg, Judge Dwyer, A. F. Broomhall, T. Russell Robinson and W. H. Bloss.

Central Station Advertising.

In connection with the twenty-ninth convention of the National Electric Light Association to be held at Atlantic City, June 5, 6, 7 and 8 next, it is proposed to repeat on a more extensive scale the exhibit of central station advertising that was given with so much success last year at Denver for the first time. Steps are now being taken to carry out this purpose, and it is believed that the exhibit will prove attractive and instructive to central station managers. It is proposed to divide the exhibit into two sections, one showing the work done by the larger companies which maintain their own force for such work and issue and prepare their own bulletins, and the other bulletins and material furnished by the new concerns that have sprung up lately to supply the smaller stations with this class of matter, many of which have already done very effective work. In addition to this a display will be made of posters, large newspaper advertising and the original drawings and sketches employed in the bulletins.

Electrical Notes from Europe.

(By Our Special Correspondent.)

A COMPETITIVE test was lately held at Paris under the direction of the Postal and Telegraph department in connection with various electrical interests, in order to find the best practical device for detecting the presence of current in a wire. Such a device is naturally of great utility, and accidents can be avoided by its use. At the same time it must be very simple as well as cheap, and made so that anyone can use it. A number of devices were presented, but some of them were too complicated and needed experience to handle them. Two of the devices received prizes as the simplest and most practical. The Miet apparatus, which took a prize of $700, consists of a stout glass tube having the form of a test-tube and corked with a rubber stopper. Through the stopper passes a brass rod having a ball on the outside, while on the end inside the tube it carries two pieces of aluminum foil which form the leaves of an electroscope. The tube is held in the hand and the ball approached to the wire, when the presence of current can be seen by the separation of the leaves. The apparatus is simple and is said to cost but ten cents. The J. B. Taylor detector, which took a prize of $200, consists of a glass bulb three inches in diameter in which is mounted a straight rod passing down through a rubber cork. On the end of the rod inside the bulb is mounted a light S-shaped piece which turns about the pointed end of the rod and is set in movement by the discharge from the ends of the piece which are pointed to this effect. By holding the ball on the outer end of the rod against the wire carrying the current the presence of the latter is detected by the rotation of the piece. This form of detector is used for high-tension currents. Another form for low-tension consists of a closed tube partly filled with gasoline. A rod passing through the stopper of the tube runs down into the liquid. The gasoline contains a fine metallic powder which lies at the bottom of the tube. When shaken up the powder remains in suspension in the liquid for a considerable time, provided the outer end of the rod does not receive current from a wire against which it is held. Should there be a current flowing, the effect is seen by the fact that the metallic powder collects upon the rod in a very short time.

One of the most extensive systems of hydraulic plants in Italy is that which is used at present to supply the region of Gallarate, Busto Arsigno and Legnano, in Lombardy. This region has a great number of spinning and weaving factories which are now using electric motors to a large extent. The largest of the hydraulic plants is located at Vizzola and has a capacity of 12,000 kilowatts, while the lines have a total length of 160 miles. There are 162 transformer stations on the system and these stations are also supplied by a second hydraulic plant at Turbigo, which receives power from the Lessin, like the first-mentioned plant. The Turbigo station has a capacity of 3,500 kilowatts. The third station of the system is located at Castellanza, near the centre of distribution, and it has a capacity of 5,400 horse-power. To these three stations is to be added a fourth plant which will be located on the Poschiavano river near the Swiss frontier. This will greatly increase the radius of distribution. The capacity of the new plant will be 40,000 horse-power.

A gas engine and dynamo group, operated by an improved form of gas producer, is built by the Gasmotorenfabrik, of Cologne. The gas-producing apparatus consists of a producer proper, a boiler and a scrubber. The movement of the engine piston draws air through the boiler, where it is charged with steam and becomes heated. The mixture is then sent through the grate of the furnace and passes through the incandescent carbon, thus forming the gas for operating the engine. At present the groups are made in two sizes, one having a sixteen-horse-power engine, coupled to a nine-kilowatt-dynamo, and the second using a fifty-horse-power engine with a thirty-six-kilowatt machine. The performance of these groups is said to be very satisfactory. Anthracite, coke, or lignite briquettes are used for fuel, and the latter especially give a great economy.

Mention has been already made regarding the large electric station which is in course of erection in the northern suburbs of Paris at St. Denis. We are now able to give some further particulars about the new plant, which will be one of the largest in Europe. Additional interest is given by the fact that all the units are to be steam turbine groups. The station lies on the bank of the Seine so that it can easily secure a coal supply from the barges. There are three main parts to the building; a large central structure which forms the dynamo room and contains the main groups; then the boiler room lying alongside the dynamo room on the right, while on the left is a corresponding space which will contain the minor apparatus, including the appliances for handling the line connections. The boiler room contains two pumps which are driven by electric motors from the Société Alsacienne, of Belfort. Two other pumping sets of the Laval pattern are direct-coupled to Breguet motors. The main boiler set includes twenty Babcock-Wilcox boilers, each having 420 square metres' heating surface. A set of motor-driven coal conveyors and other apparatus are used to take the coal from the barges and bring it into the coal bunkers which lie opposite the boilers. In the dynamo room the station is to have four main steam turbine and alternator groups when it is entirely completed. At present there are two of these groups already mounted, while a third is in erection. The steam turbine and dynamo outfit is constructed by the well-known Swiss firm, Brown, Boveri & Company, of Baden. The turbines follow the Parsons system of operating. These machines have a capacity of 10,000 horse-power each, and have a remarkably small size for so high a power, as they are but fourteen metres long. The alternators are rated at 5,000 kilowatts and operate at 750 revolutions per minute. In the main station is a substation outfit for use in furnishing the current which is needed on the premises for the lighting and the large number of motors employed for handling the coal and for different purposes. Besides a small turbine group of 300 kilowatts, operating at 225 volts, there are two rotary sets consisting each of a three-phase synchronous motor, working at 10,000 volts, coupled direct to a 375-kilowatt direct-current machine. These groups are used to convert the alternating current from the main circuit into direct current. The new St. Denis plant is to furnish a large amount of current for different purposes. Part of it is to be used on the Metropolitan subway for running the trains; and this will be needed especially when the new sections which are now in construction are opened up for traffic. Current is also to be supplied to the circuits of the Edison company, which cover

one of the main lighting districts of the city, and are now run from a station in the centre of town. A number of the new surface traction lines will also take current from the St. Denis plant, and perhaps it may be called upon to supply some other of the lighting districts of the city.

One of the large hydraulic plants in Japan is the Kyoto station, which is now running quite successfully. Power for operating it is obtained from a canal which runs from lake Briva to Osaka bay. The canal is also used for navigation between the town of Kyoto and the bay, and besides it also feeds a system of irrigation canals which are used for rice cultivation. The distance from the lake to Kyoto is about seven miles. A head of water of thirty metres (100 feet) is secured from the canal at the point where the station is erected. The plant at present contains as many as nineteen turbine and dynamo groups, making a total capacity of 1,800 horse-power. Different types of machines are used, so as to try the leading makes from America and Europe. Among them are the General Electric Company and the Westinghouse company. Pelton waterwheels are used in the station. At present the total length of the lines running from the hydraulic plant is stated to be 210 miles. It is proposed to enlarge the canal to some extent and increase the capacity of the station by adding to the outfit four new turbine groups of 1,000 horse-power each, thus doubling the output of the plant. In Japan we find that the use of hydraulic power is making considerable progress. In the mountain regions, which form a large part of the surface of the country, there are numerous waterfalls and these are already beginning to be utilized, and it is stated that over twenty-five per cent of all the electric stations in the country are run by turbines. Among the large steam plants we may mention the two leading stations of Tokio, one of which is used for lighting and the other for power. The lighting plant has a capacity of 20,000 horse-power, while the power station has no less than 40,000 horse-power. It is proposed to erect a hydraulic station in the neighborhood of Osaka, which will secure a large amount of power for the lighting circuits and tramway lines of that city and help out the already existing stations. The Uji river, which can be used for this purpose, will afford some 30,000 horse-power, and it is proposed to erect the plant at a point some twenty miles from the city.

Active measures are being taken toward the use of electric traction in the Simplon tunnel. At first it was decided to use steam for the trains, but since the tunnel has been put through it is found that the heat will be considerably higher than was expected, owing to the hot springs which are found there. Again it is difficult to ventilate the tunnel properly. Therefore the Swiss company which is operating the Simplon decided to use the electric system and a commission of engineers is visiting the leading hydraulic plants in Italy to secure information on the subject, as it is proposed to utilize the power of the Rhone which flows near the tunnel and already gave considerable power at the time of working in the tunnel.

In the Courl mines in Germany we find one of the new Zoelly steam turbine groups, which are constructed by the Siemens-Schuckert firm. The turbine is mounted together with an alternator. The latter is designed to give 1,500 kilowatts three-phase current at 2,000 volts. Some 1,500 horse-power can be developed by the turbine and it runs at 1,500 revolutions per minute. On the other side of the turbine is mounted a twenty-kilowatt exciter. The turbine carries a special governing device which operates the steam inlet for keeping the speed constant and to allow the present alternator to be run in parallel with some other machines in the same plant. By the use of the governor the speed variations do not exceed five per cent at constant load and three per cent for a load-change of 100 per cent. An oil-pressure system of lubrication on an improved system is used with the turbine and the alternator.

The German system of aerial telegraphy, which is known as the "Telefunken," is becoming rapidly developed in Europe, and already a number of large stations are erected at different points. Others are now being constructed, and among these we may mention the two stations in the island of Rhodes and on the African coast of Dernah. These two posts will send signals over a distance of 450 miles across the Mediterranean. In South America this company is erecting two stations in Peru in the interior of the country, where the forest region would have made a telegraph line almost impossible to construct. The Telefunken company is making a specialty of portable field posts for either private or military use and the posts which are now running are said to work very well. On war vessels the new system is being adopted in many of the leading countries of Europe.

A novel electric apparatus has been brought out in Belgium for producing photographic prints. It applies to bromide prints, which are made by artificial light, and is especially useful for turning out such prints in the shape of postal cards, producing the latter automatically and in quantities. The operation of the apparatus is very simple. An automatic device applies the paper from a roll or magazine against the negative; then an incandescent lamp is turned on for a time, which has been previously adjusted once for all in the case of a given negative. After the exposure, the lamp is turned off and the paper is removed from the negative and goes into a dark box; then a fresh piece of paper is applied, and so on. The apparatus is set so as to give a certain number of prints from a given negative, and each printing operation causes a ratchet wheel to advance one point. At the end of the printing an electric bell is rung by the ratchet device. By means of a rheostat the time of exposure can be adjusted from one to 200 seconds. The whole is operated by a battery of four small accumulators.

It is reported that a Danish syndicate, located at Copenhagen, has been formed for operating a system of hydraulic plants in that country. The plants, however, will be installed on Swedish territory, making use of two falls of the Laga river. A hydroelectric station is to be erected at each of the falls, one of which is the Majefos, having an eight-metre head of water, while the second, the Katefos, gives a ten-metre fall. The Laga river flows down to the sea from the Smaaland plateau, over a distance of twenty-five miles, passing through the province of Halland. It flows into the sea near Laholm. The current from the two hydraulic plants will be sent by high-tension lines to the coast town of Helsingborg in the southern part of Sweden. Submarine cables will lead from this point, crossing the Oeresund to the Danish coast.

The electric tramway system of Hong Kong is now constructed for a considerable length and new sections are being added to provide for the increase of traffic. The tramway has been installed by the English firm of Dick, Kerr & Company, of London, and is designed to give a good communication between the thickly populated districts in the centre of the

city and the suburbs, or outlying quarters, so as to favor the building up of these parts and thus relieve the central districts. A double-track line starts from the west part of the seaport and runs parallel to the sea, reaching the eastern end of the port and the village of Shaukiwan. A short branch runs in another direction from the main line. The 500-volt overhead-trolley system is used in this case and the traction lines have a total length of fifteen miles. More than half of the road is laid in the streets of the city. At present the rolling stock consists of thirty passenger cars of English build, divided into first and second-class compartments. A central station of some size is located inside the city for operating the tramways. It uses two cross-compound engines of 560 horse-power each. These are supplied by Babcock & Wilcox boilers. Each of the engines is coupled with a 550-volt generator, working at 100 revolutions per minute. Both machines work in parallel on the tramway circuits. The new traction lines have now a large amount of traffic and this is on the increase.

The electric lighting system of Hong Kong is operated by a large company, capitalized at $300,000. The electric station is located in the Wanchai quarter of the city. English machines are also used in this plant. In the station have been installed two direct-current machines, which supply the arc lamps for the city lighting. At present there are eighty-five arcs in use. Two other machines furnish current for the incandescent lamps, to the extent of 1,700 lamps of sixteen candle-power, while two other generators supply 4,000 lamps each. As a reserve, the station contains two smaller machines, each of which has about 100 horse-power capacity. Electric fans come in for a large part of the current, as these are used very extensively during the warm weather in offices and private houses. The electric lighting cables are partly underground and partly overhead and are supplied by different firms, as also the smaller apparatus.

A company has been formed at Paris for operating a new system of postal and package transport by light electric cars. It is designed to run for long distances between cities and to take packages of considerable size. A special construction has been adopted in the present case. The cars run in an underground tunnel or conduit measuring 2.40 × 3.90 metres. Two tracks are provided, and these are placed one above the other for the forward and return trip. On a trial track of this kind, which was installed in the neighborhood of Paris, the car had a square section about one metre on a side and measured seven metres long, the ends of the car being pointed. The car runs between an upper and a lower rail and, besides the running wheels, there is a pair of wheels or rollers which grasp the rail by a side pressure so as to allow the car to pass around curves easily. Motors of the triphase type are used to drive the wheels and it is expected to make a speed of 150 miles an hour. Three copper bars supply the current by rubbing contacts, using 1,000 volts and forty cycles.

Among the European hydroelectric plants which have been recently installed we may mention the Prerau station, which, although a small one, presents some interesting features. Before erecting the turbine plant, the energy was supplied by two steam-driven groups of 200 horse-power each, delivering direct current at 130 and 260 volts. A storage battery was connected in parallel on the machines. As the demand for current increased it was decided to use a water-power plant. Some two and one-half miles off there exists a fall which gives a maximum flow of 3,000 litres per second with a four-metre head of water. The highest power which can be counted upon in this case is 150 horse-power. In the hydraulic plant, which has been erected at the fall, an Escher-Wyss turbine of the Francis pattern is employed. It is designed for a flow of 3,200 litres per second and a net fall of 3.90 metres. The shaft of the turbine passes into the dynamo room and carries a pulley 3.60 metres in diameter, which forms also the flywheel. A belt connects the latter to a three-phase alternator. The turbine shaft runs at a speed of 120 revolutions per minute. The alternator is designed to give 5,000 volts at twenty-three cycles. From the station a high-tension line runs to the town, and inside the town underground cables are used. In the suburbs an overhead wiring is employed. Three-phase motors are used in a pumping plant which is located not far from the turbine station. These are high-voltage motors which operate at 340 revolutions per minute.

The Augsburg-Nüremberg Electric Company, one of the large German firms, lately installed a plant of some size at Offenbach for handling coal, especially for unloading it from the cars. The plant consists of three bridge-cranes of four tons and a revolving crane of the same capacity. The former cranes have a total length of 70 metres and an inside height above the rails of 7.9 metres. A series motor is used to drive these cranes, acting on two vertical shafts by means of straight and bevel gearing. The carriage of the crane is fitted with a sixteen-horse-power series motor for shifting it and a fifty-horse-power motor for lifting the load. Direct current at 600 volts supplies the motors. The present system of cranes will handle from 200 to 260 tons of coal per hour.

The recent concourse of electric and petrol-driven cabs, which was held at Paris, showed that considerable progress has been realized during the last year in the construction of these vehicles. The test was a severe one, owing to the rainy weather and the slippery condition of the streets, some of which have a rough paving and very steep grades. The route through town was laid out so as to give a severe test to the cabs, and it comprised a sixty-mile trip in all. The new electric cab, which is built by M. Vedrine, a prominent constructor of Paris, showed a fine performance here and took the first prize. On the test it was found that the maximum consumption of current was ninety-six watt-hours per ton-kilometre, while in ordinary running this falls as low as seventy-five watt-hours. These results are far ahead of the performance of electric cabs a few years ago.

C. L. DURAND.

Paris, January 1.

Electricity on Erie Lines.

The directors of the Erie Railroad recently authorized Vice-President J. M. Graham to organize an electrical commission to study the question of electrifying the suburban lines of the company. In all, about 250 miles will be equipped with electricity.

The first meeting of the commission was held on Thursday, February 1. The members, with Mr. Graham as chairman, are E. A. Williams, general mechanical superintendent; A. J. Stone, assistant general manager; C. H. Morrison, acting electrical engineer, and Messrs. B. J. Arnold and L. B. Stillwell, electrical experts.

It is possible that practically all of the lines in New Jersey, including the four-tracked main line across the state, will be electrified. The Erie Railroad recently announced its intention of building trolley lines parallel to its steam lines in New York state to forestall trolley competition.

Reviews of Current Engineering and Scientific Literature.

Deposits on Telephone Wires.

In this communication the writer describes an interesting occurrence observed at East London in Cape Colony, Africa. One of the residents there complained that two telephone wires passing over his iron roof were seriously injuring it and asked that they might be removed and the building reroofed at the expense of the government. In support of his statement he referred to lines of a whitish color on the roof immediately under the wires. At first it was thought that the trouble might have been caused by the moist sea-air laden with salt condensing on the wires. An examination showed, however, that the deposit, which could be scraped off, was not salt. It was found that the roof was uninjured and that the whitish substance was silica with faint traces of iron. In other words, it was simply sand which had collected on the wire when damp and had fallen off as the wire dried.—*Abstracted from Nature (London), January* 18.

Radioactivity of the Hot Springs of Dax, France.

There exist in the region of Dax, in the southwestern part of France, a large number of hot springs of which the temperature varies from twenty-five to sixty-one degrees centigrade. These different springs appear to come from one subterranean supply of which the origin has not yet been explained. They have long been celebrated as health resorts and as such they were known to the Romans. Certain of them have a large output. One, in particular, has a flow of 1,800 cubic metres in twenty-four hours. It appears to be in a continual state of ebullition, but this is due to nitrogen which is set free when the water reaches the surface. The inhabitants of Dax use the springs for furnishing water for the household and for various other purposes, and in this way save a considerable amount of fuel. The medicinal value of the springs was at first attributed to salts in solution, but analysis of the water has shown that but a small amount of salt is contained and this consists principally of calcium and sodium sulphates and chlorides. It occurred to the author, M. Albert Nodon, that the value of these waters might be due to radioactive properties. He was led to this idea from the work of Elster and Geitel, who found that air which had remained for some time in caves and other underground chambers became radioactive. He secured samples of the water and by means of specially prepared electrometers arranged to prevent errors due to the vapors given off by the water he found that the latter was radioactive to a considerable degree. The constitution of the water will now be carefully examined with a view to determining what the radioactive elements consist of and of measuring their intensity. As it is believed that these springs have been of considerable value in treating the sick, it is suggested that radioactive thermal springs might be established in large cities such as Paris, where the ailing could go for treatment.—*Translated and abstracted from L'Électricien (Paris), January* 13.

The Electric Equipment of a Direct-Current Test Room for an Electricity Supply Undertaking.

The electrical supply station of Burnley, England, has been equipped with a fairly complete testing room designed to enable motors and lamps of various kinds to be tested easily and quickly, which is here described by Mr. A. C. Johnson. The equipment consists of two switchboards, a storage battery and a motor-generator charging set. One of these switchboards is for the high-voltage—that is to say, the voltage of the electrical supply. There are four voltages available on this board: 440, 330, 220 and 110. This board is equipped with plug switches and four sets of horizontal bus-bars, which supply the following circuits: a spare circuit for testing arc lamps, a circuit running to the photometer room, a circuit for the field of the generator of the charging set and a circuit for supplying the motor of this set. The low-tension board is supplied with various circuits of size sufficient to carry 1,000 amperes. One circuit is connected to the testing batteries, and there is one used for testing large station meters, which has been very useful for checking the station instruments. The storage battery equipment consists of six cells arranged in two groups, each capable of discharging at 400 amperes for fifteen minutes. By placing them in parallel a current of 800 amperes can be obtained, or by connecting them in parallel with the charging set a current of 1,000 amperes is available. Resistances are provided on the low-potential switchboard for controlling the testing current. The charging set consists of a motor and a generator direct-coupled, mounted on an extended bed plate, both of the four-pole type. The motor has two sets of brushes, and the generator has four sets and a large commutator to cope with the heavy currents which it delivers. The motor is a shunt machine specially wound so that it can be driven at either 110, 220 or 440 volts. Its field is also suitable for any of these voltages. By suitably combining motor speed with generator field excitation any voltage between one-half and fifteen can be obtained at the generator terminals at any load between no load and full load. The maximum output of the generator is 200 amperes at fifteen volts, but at lower voltages considerably heavier currents can be obtained for short periods. This machine is separately excited from the high-tension switchboard, regulating switches and rheostats being provided there. For fine adjustments the field is first set to give approximately the required voltage, and the exact voltage is obtained by changing the field current of the motor. This booster set has another useful purpose: that of charging defective cells. Generally when one cell shows that it is in a bad condition it is customary to bring it up by overcharging the entire battery. This is, of course, an inefficient method. By means of this low-voltage booster any one cell can be overcharged alone, and thus a considerable saving effected. It is thought that the saving brought about through this convenient testing arrangement has more than paid for itself. No time is lost, nor is there any undue waste of power in testing motors, even though they have a large capacity. In connection with this testing room there is a photometer room for testing incandescent lamps. The equipment has been in use for eighteen months and has given considerable satisfaction.—*Abstracted from the Electrical Review (London), January* 19.

Calculation of Dynamos.

A method is given here by M. L. Isambert for predetermining the most economical design of dynamos. For machines rated at less than 100 kilowatts there are generally standard sizes, but for larger machines it is customary to make special designs. The author has compared machines made by different companies, which were exhibited at Paris, and

found that they differed considerably in size, although having the same rating. It seemed interesting to him to develop a method, based both on theory and practice, which would indicate mathematically the best dimensions. In order to do this it is necessary to adopt certain ratios, which may be found for any particular type of machine. These are, for example, the ratio between the length of the pole-span and the polar arc, the leakage coefficients, etc. He takes up the machine one part at a time, deduces the formulæ for each and finally brings all these separate formulæ together into a final one representing the relation between the radius of the armature and various other factors. This has the form:

$$R^5 = \frac{100\, a\, a^2 \left(\frac{P}{\omega}\right) p^5}{\omega\gamma[7.2\times 10^{-2} pg + 0.12\delta c(p-0.65)]}$$

In this formula, a is the cost in francs per kilogramme of copper on the field, and is taken as seven; c is 0.35 franc, the price per kilogramme of the sheet iron, and g is 0.35 franc, the price per kilogramme of the field casting. Substituting these values, the equation is reduced to the following formula:

$$R^5 = \frac{\left(\frac{P}{\omega}\right) p^5\, a^2\, 10^4}{\omega\gamma(p-0.41)}$$

In this, R is the radius of the armature; $\frac{P}{\omega}$ is the specific power in watts per 1,000 revolutions per minute, p is the number of pairs of poles, a a factor bringing in the ratio between the armature reaction and the magnetic leakage, and γ is the percentage of the total power of the machine lost in the field. The author has tested this formula by applying it to a number of designs and has found his figures agree with those arrived at from practice. He has found this method very useful in checking the arbitrarily selected dimensions for a new design.—*Translated and abstracted from L'Industrie Électrique (Paris), January* 10.

A Study of a Single-Phase Series Motor.

A four-pole, 200-volt, twenty-five cycle, single-phase, alternating-current motor has been tested on alternating and direct currents by Mr. George I. Rhodes. This machine is not of the most recent design, and hence its behavior can not be taken as an indication of the best that can be accomplished. The results of the study are nevertheless interesting. The characteristics on direct current are very similar to those obtained with a direct-current motor of the usual type. The curves taken on alternating current at twenty-five cycles resemble the direct current characteristics, except that the reactions of the machine are more apparent. From a comparison of the two sets of characteristics it is found that in both cases the torque increases at a greater rate than the current, but the alternating-current torque is lower than the direct-current torque for all values of the current. The difference is small at light loads, but amounts to about twenty-five per cent at fifty amperes. The impressed voltage has little effect on the torque, so that the machine will start satisfactorily as a single-phase motor even at low voltages. The speed-current curves taken in the two experiments are the same, but the alternating-current curve is much steeper. At light loads it makes little difference in speed which way the motor is operated, but at heavier loads the speed with alternating currents is about forty per cent below that of the direct-current speed. Further, the variation in speed, due to changes of voltage, is greater on alternating than on direct current. The curves approach each other as the voltage increases. The speed at 170 volts, twenty-five cycles, is forty per cent below that on direct current at the same voltage and fifteen per cent lower at 230 volts. The large impedance drop in the field-coils is responsible for this difference, to a considerable extent. A comparison of the speed and torque characteristics shows that the motor is better suited for railway work when operated on direct current than on alternating current, but it is thought that this particular motor is better than direct-current commercial motors of the same size. It cannot be expected to give as rapid train acceleration as the direct-current motor because of the lower torque. The running efficiency of this motor is between seventy-five and eighty per cent with alternating current and about eighty-five with direct current. The maximum value increases with the voltage. When operated on direct currents there was no sparking. With alternating currents sparking occurred, no matter how carefully the brushes were fitted to the commutator. It was particularly bad at the full load of fifty amperes. This sparking affected the commutator but slightly, though the brushes were badly burned. Both commutator and brushes ran hot at full load. It was found that the position of the brushes had considerable influence in the general operating characteristics of the motor. The torque was slightly increased at all loads by a backward movement of the brushes. The speed was considerably decreased by a forward lead and increased by a backward lead. The output for a given current, and hence the power-factor, were decreased or increased according as the brushes were moved in or against the direction of rotation. The power-factor could be improved seven per cent and the maximum output materially increased by a proper adjustment of the brushes. This improvement lasted only so long as the motor was run in one direction, for on reversal all of the characteristics became worse than ever.—*Abstracted from the Technology Quarterly (Boston), December.*

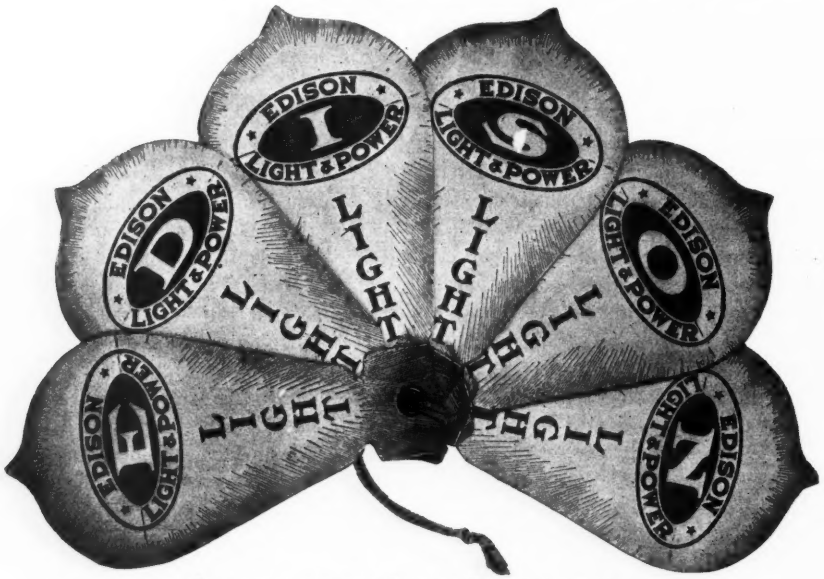
The St. Denis (Paris) Generating Station.

A large generating station is in course of construction at St. Denis, Paris, and part of the machinery is already in service. Part of the equipment of this station consists of apparatus already in hand, while the remainder will be of the latest types. The main plan of the station consists of a long generating room with generating units arranged in groups, each group being furnished with steam from a separate boiler house. The present plans call for three entirely separate boiler houses. These are arranged along the power-house, and each is supplied with coal from a separate storage house. The output of the station will be of two kinds: alternating current at twenty-five cycles and at forty-two cycles. The first will be three-phase for operating motors and motor-generators at the substations for developing direct current. The higher frequency will be used for supplying power to lights in the outlying districts. Frequencies of twenty-five and forty-two—or rather forty-one and two-thirds—have been chosen because of the advantages which the ratio of six to ten thus obtained has in the design of generators. The equipment will consist of ten 6,000-kilowatt steam-turbine alternators, with provision for two additional units of the same size. There are also five 300-kilowatt, direct-current generators driven by turbines, delivering current at 230 volts. In addition, the station contains a group of three motor-generator sets for converting the high-tension alternating current into direct current at 220 volts. A battery and booster charging set are also provided. The alternators generate three-phase current at 10,230 volts, and two-phase current at 12,300 volts.—*Translated and abstracted from La Revue Électrique (Paris), January* 15.

Methods of Getting New Business.

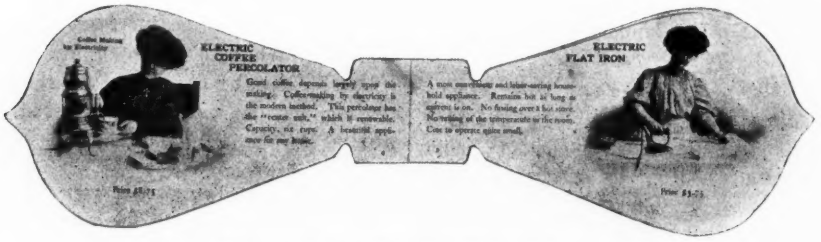
A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

At the electrical show, held at the Coliseum, Chicago, Ill., from January 15 to 27, the Chicago Edison company took a very prominent part in giving publicity to the uses of electricity. The company made use of a handsomely appointed booth situated at the intersection of the two main aisles, every section of this booth being designed with a view to giving full expression to the educational opportunities an exhibition of this nature affords. The "Electric City," published by the Chicago Edison company and the Commonwealth Electric Company, was printed daily and folded on an electrically driven printing press and folding machine. Various forms of heating and cooking utensils were in operation, and many souvenirs were distributed to the visitors. Two of the pieces of literature distributed attracted a great deal of attention. These were both in the form of an incandescent bulb, one being a folder which called attention to the advantages of various forms of electrical devices. This included descriptions of the electric curling iron heater, the electric chafing dish, the electric coffee percolator, the electric flat-iron, the electric heating pad, electric fans, closet lights, the luminous electric radiator and various auxiliaries. The other souvenir, when opened, took the form of a rather unique fan. This attracted a great deal of favorable commendation, and was not only eagerly picked up each night of the show, but was retained as an evidence of the genius of the present-day advertiser. One of the features of the electrical cooking and baking demonstration was the free distribution of cookies made from a selected recipe, cut in the form of an oval with the lettering of the Edison trade-mark reproduced thereon.



Souvenir from the Chicago Edison Company.

An Attractive Folder in Red and Gold from the Chicago Edison Company.



The Chicago Edison Company Folder Opened Up.

The following quotation is taken from the *Electrical Engineer* (London), January 19:

"Electricity, like other salable commodities whose virtues are extensively proclaimed, must be brought into the advertising market if it is to gain a large measure of popular support, for the great British public are not too prone to go over to anything about which they have not heard much. As regards electric power the gas companies are extremely active in bringing power-users to adopt gas engines. The electrical company has to overcome that competition, together with the inertia of the ordinary man against change. It is imperative that the numerous advantages of electric lighting and driving should be put before him in the most attractive light and kept before him persistently. The electors of Tyneside are being appealed to not only by candidates for political favors but by the electrical companies in the district, who have formulated a constructive policy which will vie with that of either of the political parties. 'Our attitude,' reads the company's manifesto, which is being extensively circulated in the Tyneside districts, 'is in favor of a progressively liberal use of electric lights as conducing to the most efficient home rule and control of financial questions. Education is leading the community to a perception of the fact that electricity is more economical than Chinese labor, and for these reasons we solicit your suffrages.' We commend this to the support of a wide electorate."

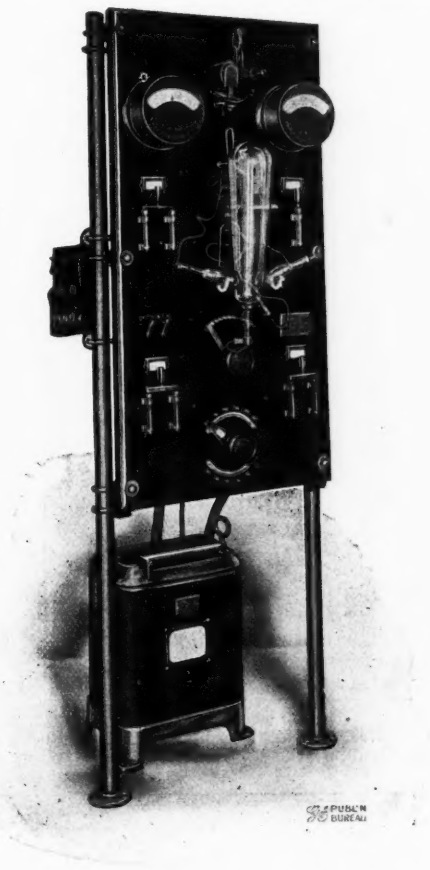
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Charging Telephone Batteries.

Hitherto the mercury arc rectifier manufactured by the General Electric Company has been most extensively used in automobile work, where it has been found to be one of the simplest and most convenient methods of charging automobile storage batteries. The same reasons which have led to its adoption for this purpose also adapt it to the requirements of telephone battery charging. Already the comparatively low cost, compactness and high efficiency of this method of transforming alternating into direct current has created a demand for a telephone charging panel and this has been met by the outfit developed by the General Electric Company.

The neat and compact appearance of one of these sets is seen in the accompanying illustration of a thirty-ampere rectifier outfit. It consists of a mercury arc rectifier tube mounted on a black enameled slate panel with switches, instruments, etc., and the necessary reactance coils. This panel stands seventy-six inches high and is twenty-four inches wide, and, as it need stand but twenty-four inches from the wall, is compact and self-contained. In the centre of the panel the rectifier is mounted in a substantial holder in such a manner that the shake necessary to start the tube in action can be easily given.



ALTERNATING-CURRENT RECTIFIER FOR CHARGING TELEPHONE BATTERIES.

Grouped about the rectifier are the switches and instruments, the whole presenting a neat and attractive appearance. The switches include starting, alternating and direct-current line switches and load switches. A circuit-breaker is also included in the direct-current line. High-grade instruments are supplied, the ammeter having its zero at the centre of the scale so as to read in either direction. There is also provided an external shunt with thirty-foot leads so that the current may be measured at a convenient point. A small selective switch, shown at the left centre of the panel, is so connected that the direct-current voltage may be conveniently taken across the battery terminals, rectifier terminals, etc.

On the floor beneath the panel proper is located the reactance coil for adjusting the alternating-current supply, thereby controlling the direct current. In addition the General Electric Company furnishes with this outfit a suitable reactance, which is so connected that it reduces the humming on the telephone circuits to a minimum. Tests of this rectifier, made by the American Telephone and Telegraph Company, indicate that there is no noise on the line when the batteries are being charged. This is a point of great importance in the satisfactory operation of any charging device for telephone service.

The contract for the electrical equipment of the road between Pittsburg and Butler, to be operated by the Pittsburg & Butler Railway Company, has been awarded to the Westinghouse Electric and Manufacturing Company. The road is thirty-three miles long and will be equipped with single-phase, alternating-current apparatus.

The New Home of the Central Electric Company.

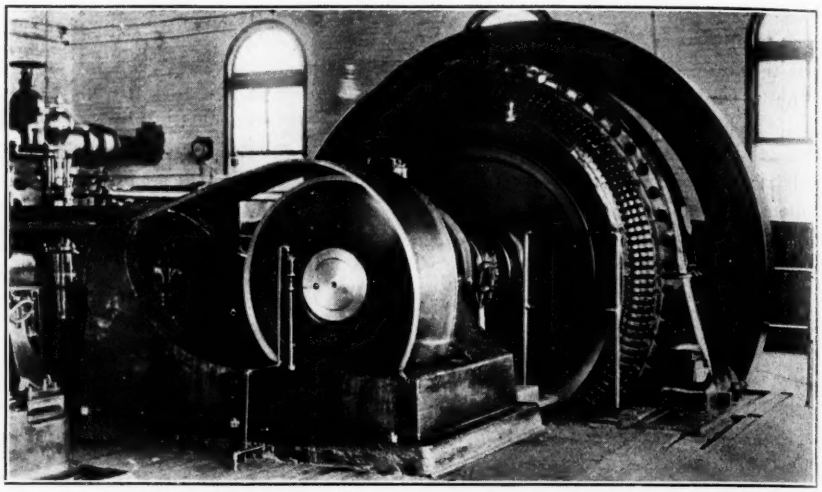
On the morning of February 11, 1905—just about one year ago—the offices and warehouse of the Central Electric Company, Chicago, Ill., were entirely destroyed by fire. Attention has been called to the remarkable celerity with which arrangements for installing a new equipment and resuming business were made within one hour after the usual time for opening. It will be of interest now to know that on February 1, 1906, the company is fully established in a new building built especially for its requirements. The company has a floor space approximating 60,000 square feet, and the equipment includes every modern appliance to facilitate the prompt handling of business. The stock of goods is complete in every detail and the company is starting out to make a new record for quick shipment of orders. The new building is located at 264-270 Fifth avenue, Chicago.

An Important Understanding in the Manufacture of Incandescent Lamps.

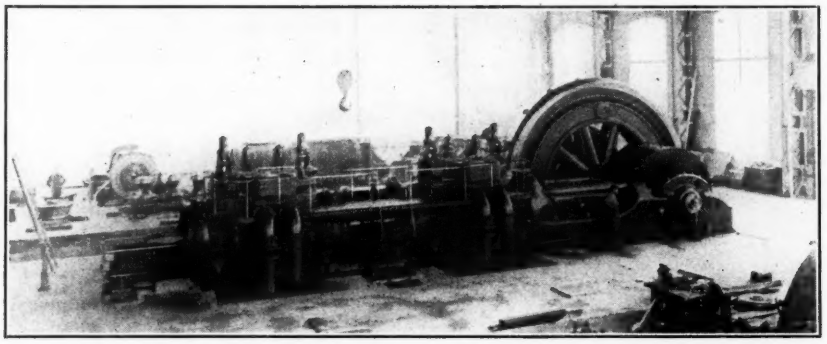
The American Electric Company, of New Jersey, and the Missouri American Electric Company, of Missouri, announce that an understanding has been arrived at between the General Electric Company, the Edison Electric Light Company, the American Electric Company and the Missouri American Electric Company relative to the patent litigation against the Missouri American Electric Company, such arrangement being satisfactory to all the parties in interest. The companies announce that "all such litigation between the parties has been terminated and that the American Electric Company, of New Jersey, and the Missouri American Electric Company, of St. Louis, Mo., have the legal and undisputed right to the use of all patents on which monopoly is claimed by the National Association of Licensed Manufacturers of Incandescent Lamps." The company also states that it is "the only company in the United States working under our own patented machinery and processes, with the legal right to use all patents under which the National Association of Licensed Manufacturers of Incandescent Lamps are licensed."

Some Recent Allis-Chalmers Installations.

The new Crystal City works of the Pittsburg Plate Glass Company, now under construction at Crystal City, Mo., when completed will be equipped with one of the largest electrical plants of its kind in the country. A notable feature of the power equipment for the new plant is the installation of an 1,800-brake-horse-power Allis-Chalmers gas engine unit direct-connected to a 1,000-kilowatt generator. This engine is of the well-known four-cycle, double-acting Nurnberg type. It is a horizontal, four-cylinder, twin-tandem engine with a forty-two-inch stroke and a speed of 107 revolutions per minute. The unit is designed to operate from producer gas. All moving parts are arranged for automatic and continuous lubrication under pressure. The gas engine and alternator will be arranged to run in parallel with other units. This company has also purchased the famous "Big Reliable" Allis-Chalmers horizontal and vertical compound engine which, with its generator, was used during the Louisiana Purchase Exposition at St. Louis. This unit will be installed at the new Crystal City plant. The "Big Reliable" is of the type designed for the Manhattan power-house, New York city. It is direct-connected to a Bullock 3,500-kilowatt, 2,200-volt, three-phase, twenty-five-cycle generator with a speed of seventy-five revolutions per minute.



425-Kilowatt Bullock Engine-Type Alternator Installed in the Power-House of the Indianapolis, Shelbyville & South Bend Railroad Company, Fairfield, Ind.

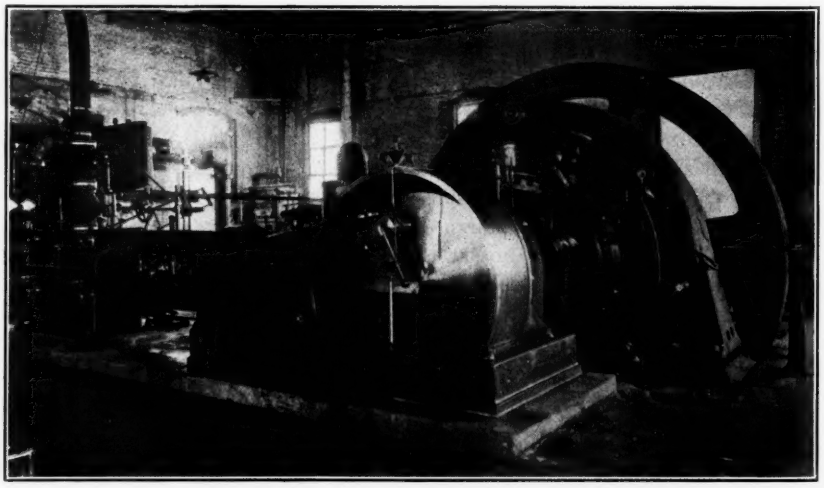


Double-Acting, Tandem, Nurnberg Gas Engine—1,800 Brake Horse-Power—Driving Direct-Connected, Alternating-Current Generator.

In mining the Allis-Chalmers Company has recently made a number of installations. One of these is the installation of a complete electric power plant equipment for the McKell Coal and Coke Company, of Glen Jean, W. Va., at the mining properties at Kilsyth, W. Va. The new equipment will consist of a twenty-six-inch by forty-two-inch heavy-duty Allis-Chalmers engine and generator unit, 500 kilowatts, twenty-five cycles, with switchboard, lightning arresters, rotary converters and transformer equipment complete. The Allis-Chalmers Company will superintend the erection of the plant at Kilsyth and the substations, which are expected to be ready for operation in April.

The Canadian representatives of the Allis-Chalmers Company recently received an order from the Canadian Forty-Mile Gold Dredging Company, Toronto, Canada, for a special gold dredge equipped with five and one-third-cubic-foot buckets. The contract covers the entire machinery equipment complete ready for operation, including an electric light plant, two boilers of 100 horse-power each, engines, pumps, etc. The dredge will be ready for use early in May.

For general lighting and power purposes the Belleville Gas and Electric Company, composed entirely of local capitalists of Belleville, Ill., has completed arrangements through the St. Louis office for the purchase of a Reliance Corliss engine unit direct-connected to an Allis-Chalmers alternating-current generator unit with exciter and auxiliary apparatus. The engine will be of the heavy-duty type, thirty-inch by forty-eight-inch, non-condensing,



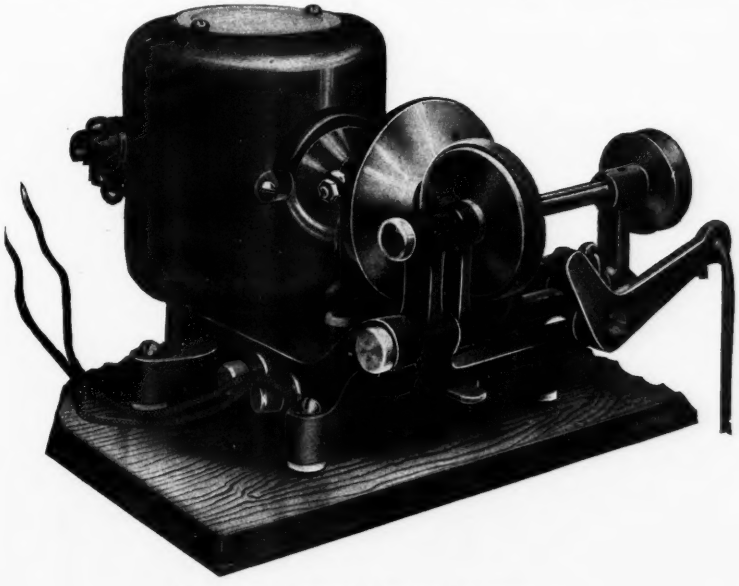
Allis-Chalmers Unit Installed in Plant of Cedar Rapids & Marion Railway, Similar to That of the Winona Interurban Railway Company, Winona Lake, Ind.

direct-connected to a 550-kilowatt, sixty-cycle Allis-Chalmers generator.

For interurban railway work the Winona Interurban Company proposes to run a line from Warsaw to Goshen, Ind.—about twenty-seven miles. The Allis-Chalmers Company will furnish the electrical equipment for the proposed line, including power-house and machinery, through the Electrical Installation Company, of Chicago. It is expected that the line will be in operation by April. The equipment specified will consist of two Allis-Chalmers cross-compound, condensing engines to drive two 600-kilowatt Allis-Chalmers alternators, twenty-five cycles; six quadruple seventy-five-horse-power motor equipments; one 300-kilowatt alternator; three 300-kilowatt rotary converters with transformers, reactance coils, etc., and the usual auxiliary apparatus for substation equipment.

The "Paragon" Sewing-Machine Transmitter.

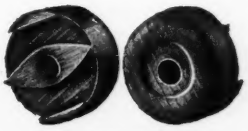
The accompanying illustration shows the factory-type, direct-current "Paragon" sewing-machine transmitter placed on the market by the Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass. This machine represents the latest development in the art of operating sewing machines by means of electric motors. The drive between the sewing machine and the transmitter is positive, with a speed variation ranging from a few stitches per minute to the maximum. As may be seen from the illustration, a light rod is provided to connect the operating switch with the treadle of the machine. A gentle pressure on the treadle opens the switch and starts the motor, and further depression gradually increases the speed of the machine as desired.



"Paragon" Sewing-Machine Transmitter.

Blake Compressed Cleats.

The accompanying illustrations show a new form of cleat which the Blake Signal and Manufacturing Company, 246 Summer street, Boston, Mass., has placed on the market for all interior low-voltage wiring where the Blake insulated staples can not be driven. These cleats are designed to be used where circuits run over plastering and similar substances. The cleats are treated so as to be impervious to dampness and moisture. They will not break under the blow of a hammer, so that wire nails may be used as well as screws. When stringing long runs of wire the end cleats will hold the slack until the wire is secured at intermediate points. The illustrations show the application of this cleat with either single or double cord.



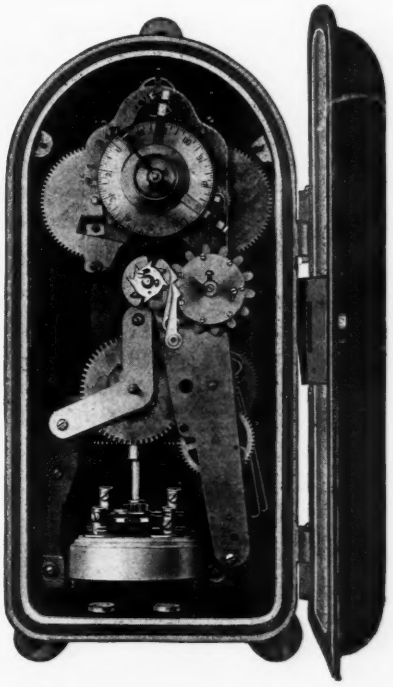
Compressed Cleats.

Compressed Cleat and Single Cord.

Compressed Cleat and Double Cord.

The Redding Automatic Time Switch.

The automatic time switch shown in the accompanying illustration is made by the Redding Automatic Time Switch Company, Boston, Mass. This time switch is designed especially for use on poles for street lighting. It is also made for turning off electric signs for lamps in store windows, for lamps in halls of apartment houses and for other positions where a selective turning on or off of the current is desired. The time switch is operated by a Seth Thomas duplex eight-day clock. The wires pass up through the bottom of the case directly to the switch and are entirely concealed, avoiding risk of short-circuiting. The switch is operated by a strong steel spring, and the instrument is provided with a seven-day wheel, by means of which the switch can be made to operate every day or to skip holidays or other times when the lights are not wanted. The switch is enclosed in an ornamental iron case, made waterproof, and fitted with a rubber packing, so as to make it water-tight and keep out the rain when the door is closed.

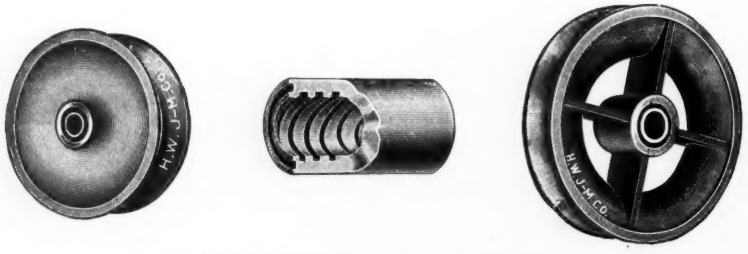


Redding Automatic Time Switch.

A New Departure in Trolley Wheels.

The H. W. Johns-Manville Company, New York city, has recently placed on the market a new form of trolley wheel, made of absolutely pure copper, purified, hardened and made tough by a special treatment. These wheels have been subjected to severe tests in actual service and, the company claims, have demonstrated exceptional qualities. The salient feature of the pure copper wheel which will appeal to the operating railroad man is economy. The company claims a greater mileage and a smoother wearing, with the elimination of pitting or burning.

In the manufacture of these wheels the best grade of pure lake copper is used, and this is treated chemically so as to reduce to a minimum any ingredients there may be in the copper in its crude state and by a further chemical process excluding the action of the atmosphere, subjecting the copper to the action of carbon to remove oxygen and to render the copper solid when cast, thus increasing its malleability and durability. A still further process toughens the metal without hardening it, with the result that the wear is reduced to a minimum, and the conductivity of the wheel, the company claims, is equal to that of the wire.



NEW TROLLEY WHEELS AND BUSHING.

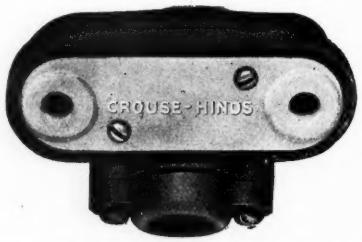
These wheels are furnished with the "J-M" special trolley-wheel bushings, made from a special metal peculiarly adapted for this purpose. The tenacity of this metal, it is stated, is equal to mild steel with a compressive strength of about 130,000 pounds per square inch. Its ductility and toughness are such that it will not crack when distorted by this load. These bushings are packed with specially prepared packing, which is not only antifriction, but also a lubricant of high grade.

The Consolidated Light and Power Company is completing at Pluma, South Dakota, a 6,000-horse-power plant for light and power for its mining operations. Electrical treating of ores on an extensive scale is to be taken up.

Crouse-Hinds Company's "Condulets."

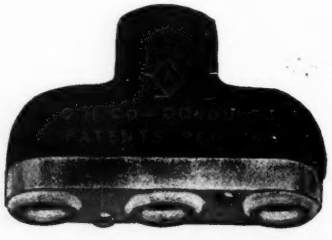
The Crouse-Hinds Company, Syracuse, N. Y., has placed upon the market a new and complete line of conduit fittings under the trade-mark "Condulets."

This line of conduit fittings will appeal to all electrical men who have had anything to do with engineering or installing conduit for surface interior wiring.



"CONDULET" FOR SERVICE ENTRANCE WIRES.

The plumber and steam fitter have for many years had a complete line of fittings to meet all conditions of their work; but the electrician has been greatly handicapped by being unable to obtain a complete and standard line of fittings and has been obliged to meet the requirements and conditions as they arose as best he could with improvised devices.



"CONDULET" FOR RIGID CONDUIT.

The catalogue descriptive and illustrative of "Condulets" just published by the Crouse-Hinds Company makes it possible for the electrical man to select fittings which will meet practically all of his requirements in connection with the installation of conduit the same as the plumber and steam fitter have been able to do for so long. Heretofore when it was desired to continue from conduit to open work there has been difficulty in securing a fitting to meet the requirements of the National Electrical Code reading:

"Wires must be rigidly supported on non-combustible, non-absorptive insulators, which will separate the wires from each other and from the surface wired over in accordance with the following table:

Voltage.	Distance from Surface.	Distance between Wires.
0 to 300	½ inch	2½ inches"

By the use of "Condulets" the above requirement is properly taken care of and the fittings are so designed and arranged that the wires leave the conduit with the proper separation and protection.

The appearance of these fittings will also appeal to those desiring to install a neat and complete system of conduit wiring and the many places where "Condulets" can be used to advantage, and where there is nothing else that will meet the requirements, will be readily seen by those familiar with conduit construction after having once looked over this catalogue of the Crouse-Hinds Company on "Condulets." These "Condulet" fittings are also very effectively used where conduit work is installed to apparatus such as motors, arc lamps, rheostats, knife switches and meters.

"CONDULET" WITH COVER FOR WEATHERPROOF SOCKETS.

The Crouse-Hinds Company is rapidly developing this line of fittings further than they have yet shown and promise as complete a line of fittings as the plumber and steam fitter now have at their disposal.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

SOUTHERN NEW ENGLAND TELEPHONE COMPANY TO ISSUE NEW STOCK—At the annual meeting of the stockholders of the Southern New England Telephone Company, held at New Haven, Ct., January 30, the directors were unanimously authorized to issue $1,000,000 new stock, making the total issue $6,000,000. The old directors and officers were reelected.

CANADIAN PACIFIC PLANS—It has been announced that the substitution of electricity for steam as a motive power is under consideration by the Canadian Pacific Railway. It is expected that tests will be made within the next six months on the Montreal-Quebec section. If this experiment should prove successful the whole line of railway may be gradually converted into an electric road. According to the present intentions the preliminary tests will be made with power from the Shawinigan falls.

TO SELL THE LACKAWANNA & WYOMING VALLEY ELECTRIC RAILWAY—It was reported last week that negotiations were virtually completed for the purchase of the Lackawanna & Wyoming Valley third-rail system between Wilkesbarre and Scranton, Pa., by the American Railway Company, which has recently secured control of nearly all of the traction lines in Scranton and vicinity. This third-rail system was built at an estimated cost of $6,000,000. This amount is outstanding in collateral notes secured by the stock of the company, which it is purposed to pay off by the proceeds of the sale.

NEW POWER PLANT FOR COLORADO—Plans have been filed at Gunnison, Col., looking to the building and equipping of a large reservoir and power plant by Albert B. Sanford, of Denver, Col. It appears that Mr. Sanford has located an ideal point where a large storage capacity can be had, and where the stream shows ample fall in Taylor park and in the cañon below. It is purposed to construct a dam 150 feet high. At 100 feet the lake thus formed will have a capacity of nearly four and one-half billion cubic feet, and will cover 2,000 acres. Estimates place the amount of available power at from 25,000 to 30,000 horse-power.

TRANSMISSION LINE BEING RUN TO APIZACO AND PUEBLA, MEXICO—The Mexican Light and Power Company, Limited, has begun work on the construction of a new transmission line from the Necaxa transmission line at Irolo to Apizaco and Puebla. This branch transmission line, including the receiving and distributing stations at Puebla, will necessitate an expenditure of about $2,000,000 Mexican money. The construction of the line will be in charge of Lewis W. Henry, superintendent of the transmission department, and the works at Puebla will be under the care of Melton Ulmer, assistant general manager of the company. The company expects to be able to supply electrical energy to the city of Puebla in about six months.

BIG SPOKANE RAILWAY COMPANY—The Inland Empire Railway Company has been formed with a capital of $20,000,000 at Spokane, Wash. It is understood that the prime purpose of the corporation is to consolidate the present electric lines of the Graves group into a large system radiating in all directions from Spokane. The new corporation, which will have an authorized issue of $10,000,000 in common stock and an equal amount in preferred stock, is organized by J. P. Graves, president of the Spokane Traction Company and of the Spokane & Inland Company; F. A. Blackwell and Waldo G. Paine, of the Coeur d'Alene & Spokane Railway Company; F. Lewis Clark and Aaron Kuhn, of the Spokane & Inland Company; W. G. Graves, attorney for the Graves lines, and W. G. Davidson, of the Spokane Terminal Company.

READING UNITED TRACTION COMPANY TO ERECT LARGE POWER-HOUSE—One of the improvements to be made by the United Traction Company at Reading, Pa., during the present year will be the erection of a modern power-house along the west bank of the Schuylkill river. This will be a one-story brick structure 150 feet by 600 feet. The plant will be capable of furnishing 10,000 horse-power, and the most modern equipment will be introduced. The object of the company is to provide for future needs of the public. It will be possible to supply electricity not only in the city, but in the suburban towns and rural districts along the lines of the various trolleys. It is estimated that the plant, when completed, will cost in the neighborhood of $1,000,000. Operations will be commenced early in the spring, or as soon as the site is definitely located.

A NEW INTERSTATE TELEPHONE COMPANY—The New State Telephone Company, organized under the laws of Iowa, has filed articles of incorporation with a capital stock of $1,000,000. The incorporators are Charles G. Cockerell, Jefferson, Iowa; W. H. Leathers, of Leathers; M. M. Head, of Jefferson; J. C. Hammond, of Mapleton; T. B. Lutz, of Mapleton; Joseph Mattes, of Obebolt, and Ira Conger, of Cherokee. The new concern specifies that it intends to do a general telephone business and establish lines in the states of Iowa, Minnesota, Nebraska, South Dakota, North Dakota, Kansas, Missouri and Illinois. The company reserves the right to exempt the private property of its members or stockholders from liability for corporate debts. In the division of capital stock it is provided that $500,000 shall be preferred stock and $500,000 shall be common stock.

STEEL TOWERS FOR CONSTRUCTION WORK—Preparations are being made by the Iroquois Construction Company, the contracting company that is building the transmission line of the Niagara, Lockport & Ontario Power Company, for the erection of another double line of steel towers alongside the line which is partially completed from Lockport to Syracuse, N. Y. This will make four lines of towers between the two cities, and it is stated that when the four-tower line is fully equipped it will carry cables enough to transmit 120,000 horse-power, or within 60,000 horse-power of the total energy that the Niagara, Lockport & Ontario Power Company can obtain from the Ontario Power Company under the existing contract. The contract provides for selling to the Niagara, Lockport & Ontario Power Company 60,000 horse-power by the Canadian company, and an option on 120,000 horse-power—in all, 180,000 horse-power being available to the American company.

UNITED RAILWAYS OF SAN FRANCISCO—At the meeting of the stockholders of the United Railways Investment Company, of San Francisco, held in Jersey City, N. J., a plan to increase the capital stock was agreed to. The common stock was increased from $10,000,000 to $25,000,000. The new stock is to be used for the purpose of paying back dividends on the preferred aggregating $900,000, and to take over a majority interest in the Philadelphia company. In addition to increasing the common stock of the United Railways Investment Company the stockholders authorized the directors to issue 40,000 shares of the increased capital to directors and officers of the subsidiary companies at not less than par. It was decided to take up the matter of giving the right to employés of subsidiary companies to purchase stock at a subsequent meeting. It was also decided to authorize the directors of the United Railways Investment Company to purchase $1,000,000 of the notes of the company, and to set aside, at their discretion, $1,000,000 of the stock of the company for that purpose.

GRAND FALLS POWER COMPANY TO BEGIN WORK—The Grand Falls Power Company, which is purposing the development of the Grand Falls water power at Grand Falls, New Brunswick, to generate electricity, has forwarded plans and specifications to Ottawa, and is awaiting the approval of the Governor-General. The company purposes to construct a concrete dam at a point 750 feet above the falls, across a narrow portion of the river. The dam will be twenty-eight feet high and 540 feet long between abutments. It is estimated that the dam will effect a back water of about twelve miles. The forebay and gatehouse will be located in the cove of the upper basin near the Portage road, and some 1,500 feet above the falls. This will be built of concrete reenforced with steel rods. Seven reenforced concrete conduits will converge from the forebay and enter the hillside close together. The top of the underground tunnel will be from eighty to 100 feet beneath the town, and the conduits will be connected by steel feeder pipes with a power-house on the lower basin below the falls.

NEW INCORPORATIONS.

LANSING, MICH.—Watson Telephone Company. $5,000.

NEOLA, KAN.—Neola Mutual Telephone Company. $1,000.

MINNEAPOLIS, MINN.—Lincoln County Telephone Company. $50,000.

ABILENE, KAN.—Riverside Light and Power Company. $50,000.

COLUMBUS, OHIO—The Lancaster Telephone Company. Increased from $100,000 to $150,000.

ALBANY, N. Y.—Columbia Telephone Company, of Columbia county. Increased from $50,000 to $200,000.

SALT LAKE CITY, UTAH—The Citizens' Heating and Power Company. Increased from $2,500 to $500,000.

SAN FRANCISCO, CAL.—The General Electric Power Company, of California. Increased from $1,000,000 to $7,500,000.

LINCOLN, NEB.—Star Telephone Company. $1,440. Officers: W. D. Sherwood, president, and F. R. L. Brust, vice-president.

ELKHART, ILL.—Elkhart Independent Telephone Company. $1,250. Incorporators: G. G. Taylor, A. W. James, J. C. Taylor.

SPRINGFIELD, ILL.—Grand Telephone Company, El Paso. $1,100. Incorporators: E. P. Armstrong, J. C. McGraw, C. A. Gull.

DONGOLA, ILL.—Dongola Home Telephone Company. $2,500. Incorporators: B. F. Crabtree, Thomas R. Baugh and J. F. Karraker.

GUTHRIE, OKLA.—The Hennesey Electric Light, Power and Ice Company. $15,000. Directors: Fred Ehler, J. W. Smith and C. C. Smith.

HOOPESTON, ILL.—Hoopeston Gas and Electric Company. $200,000. Incorporators: Frederick A. Platt, William L. Jenks, Henry L. Hanley.

GLENWOOD, WIS.—Glenwood & Downing Light and Power Company. $15,000. Incorporators: Fred T. Yates and A. Yates and F. W. Downs.

MADISON, WIS.— Telephone and Telegraph Company, Milwaukee. $25,000. Incorporators: Samuel E. Hall, E. A. Conway and L. J. Conway.

WASHINGTON, N. J.—The Washington Electric Company. $50,000. Incorporators: William H. Houston, William W. Severing, William P. Greene.

SPRINGFIELD, ILL.—Chillicothe Water, Light and Power Company. $75,000. Incorporators: W. H. Foster, Frank H. Earl and Charles A. Kingsbury.

SPRING GROVE, ILL.—Spring Grove Telephone Company, Spring Grove. $10,000. Incorporators: Joseph E. Meredith, Anton Schaefer, Henry C. Sweet.

AUSTIN, TEX.—The Rising Star Electric Light Company, of Eastland county. $10,000. Incorporators: H. E. and W. E. Anderson and W. A. McSpadden.

MADISON, WIS.—The York Center Telephone Company, of Loyal Clark county. $1,000. Incorporators: W. J. Bush, C. H. Brown, and Dr. H. H. Christofferson.

PIERRE, S. D.—Pioneer Rural Telephone Company, Hitchcock, Beadle county. $5,000. Incorporators: Charles A. Phillips, James Murphy and John E. McGill.

NASHVILLE, TENN.—The Mountain City Telephone Company. $5,000. Incorporators: J. W. Tipton, R. E. Donnelly, J. M. Lacy, L. F. Miller and J. L. Curtis.

SPRINGFIELD, ILL.—Hardin County Telephone Company, Elizabethtown. $6,000. Incorporators: Tudorf O. White, Daniel W. Whittenberg and Robert Thacker.

OLYMPIA, WASH.—Spokane Northern Electric Railway Company, of Spokane. $250,000. Incorporators: Francis H. Cook, L. C. Cook and Austin A. Gubser.

BOSTON, MASS.—Bolton Telephone Company. $1,500. Officers: president, Edward D. Emerson; treasurer, J. Wilkinson Clapp; directors, Edward D. Emerson, J. Wilkinson Clapp and Guy T. Emerson.

NASHVILLE, TENN.—The Elizabethton Lighting and Power Company. $5,000. Incorporators: L. F. Miller, J. M. Lacy, J. L. Curtis, J. W. Tipton and E. E. Hunter.

INDIANAPOLIS, IND.—Bloomington Southern Railway Company. $50,000. Directors: John C. Welling, J. F. Titus, W. G. Bruen, Blewett Lee and A. P. Humburg, all of Chicago.

MILWAUKEE, WIS.—Ettrick Telephone Company, Ettrick, Trempealeau county. $8,000. Incorporators: F. A. Knutson, H. O. Syverson, A. J. Hogden, H. C. Erickson and A. M. Hilleckson.

LANCASTER, PA.—Akron, Brownstown & Lancaster Street Railway Company. $66,000. Directors: Dr. A. V. Walter, Brownstown; J. Scott Dickey and Frank J. Rieker, Lancaster, and George D. Landis, Landis Valley.

CAMDEN, N. J.—The Lexington & Interurban Railways Company. To operate and maintain electric railways in the state of Kentucky. $4,000,000. Incorporators: Frank R. Hansell, John A. MacPeak, George H. B. Martin.

INDIANAPOLIS, IND.—The Capital Circuit Traction Company. $10,000. To build an interurban line between the cities of Greensburg, Noblesville, Lebanon, Danville, Martinsville, Franklin and Shelbyville. Directors: James N. Crabb, C. Eugene Worth, Charles E. Averill, A. R. Tucker and J. W. Trotter.

OLYMPIA, WASH.—The Montana Miners' Electric Railway and Power Company. To construct and maintain an electric railway from Libby, Mont., to suburban towns. $150,000. Incorporators: W. R. Sharp, W. H. Lueders, H. H. Howard, C. R. Fairman, all of Tacoma, and R. J. McCorkle, of Libby.

CHARLESTON, W. VA.—Briar Creek Railway Company. To build and operate a railroad from Brounland, on the Coal River & Western Railway, to the mouth of Davis creek, on Kanawha river. $100,000. Incorporators: Thomas L. Broun, D. G. Courtney, C. C. Watts, D. C. T. Davis, Jr., and E. Fontaine Broun, all of Charleston, W. Va.

WELLSBURG, W. VA.—Wellsburg, Bethany & Washington Railway Company. To build a railroad from Wellsburg to Washington. $150,000. Incorporators: T. E. Camblett, of Bethany, W. Va.; H. C. Lazear, W. W. Beal, Jr., J. S. Liggett, S. George, Robert Scott, B. F. Harden, F. A. Chapman, of Wellsburg, and Frank H. Mann, of Cleveland, Ohio.

MARYSVILLE, OHIO—Union County Telephone Company. To construct lines connecting Marysville, Richwood, Magnetic Springs, Milford Center, Warrensburg, North Louisburg, Mechanicsburg, Mount Victory, West Mansfield, East Liberty, Middlesburg and Rosedale. $200,000. Incorporators: N. E. Liggett, Wallace C. Fullington, W. O. Shearer, George P. Whitney, E. Courtright.

OSCEOLA, WIS.—Osceola Farmers' Mutual Telephone Company. To conduct a telephone system in Polk, Barron, St. Croix and Burnett counties, Wisconsin, and in the state of Minnesota. $25,000. Directors: John Getschel, Sam Francois, A. E. Roese, Charles H. Oakley, George A. Taylor, Osceola; Anton Nelson, Frank L. Corey and George F. Clark, Dresser Junction, and A. F. Bursch, Otisville, Minn.

CLINTON, IOWA—People's Gas and Improvement Company. Organized for the purpose of acquiring interurbans, street railway, gas and electric interests and to operate properties in which the officers are interested. $500,000. Officers: president, George H. Higbee, of Burlington; vice-presidents, E. C. Walsh, Albert N. Edwards and Edward Hidden, the latter two of St. Louis; secretary and treasurer, C. H. Walsh, of Burlington.

LINCOLN, NEB.—Omaha & Southern Interurban Railroad. To build a line from Omaha to Fort Crook, Neb., through South Omaha and Sarpy county, to Bellevue and Fort Crook, with privilege of extension south through Cass, Otoe, Nemaha and Richardson counties to the southern line of the state at some point in Richardson. $1,000,000. Incorporators: G. C. Barton, G. W. Wattles, W. V. Morse, F. T. Hamilton, W. A. Smith, C. R. Tyler.

ELECTRIC LIGHTING.

MARION, MICH.—The Marion council has awarded to E. S. George a franchise for electric lights.

LANCASTER, N. Y.—The Lancaster village trustees have entered into a five-year contract for street lighting.

TOLEDO, OHIO—The Toledo Gas, Electric and Heating Company has accepted the nine-cent commercial electric lighting rate fixed by the former city council.

CORINTH, MASS.—Corinth has granted a franchise for an electric light plant to W. J. Lamb, Simon Rubel, M. T. Bynum, Abe Rubel, of Corinth, and C. Lennen, of Chicago.

HARRISBURG, PA.—The following officers were elected by the Harrisburg Light, Heat and Power Company: president, E. Z. Wallower; vice-president, Harry C. Ross; general manager, Charles H. Kinter; secretary and treasurer, H. W. Stone.

NEWBURGH, N. Y.—At the annual meeting of the Newburgh Light, Heat and Power Company the following officers were elected: president, W. R. Beal; secretary and treasurer, T. R. Beal; directors, W. R. Beal, T. R. Beal, John L. Wilkie, F. N. Bain, R. A. Davidson.

STEWARTSTOWN, PA.—It is reported that York capitalists have purchased the George W. Riley property on Deer creek, in Harford county, and that an electric power plant will be built to furnish electricity for Stewartstown borough and the surrounding country.

PLEASANTVILLE, N. J.—The Pleasantville city council has awarded the lighting contract to the Pleasantville Electric Company to furnish lights for the borough at the rate of $50 per lamp. The lights are to burn from sunset to midnight. The contract is for five years.

TEKOA, WASH.—The Tekoa town council has granted the Mahoney Electric Light and Plumbing Company a twenty-five-year franchise to furnish electric light, heat and power in the town. By the provisions of the ordinance the council is to fix the maximum rate for light for municipal purposes.

ALBANY, N. Y.—In the application of the Broadalbin Electric Light and Power Company for a certificate of authority to do business and for consent to issue $50,000 of stock and $50,000 of bonds, an order was issued by the commission allowing the company to issue $40,000 of bonds and $7,500 of stock.

ALBANY, N. Y.—In the matter of the application of the Genesee County Electric Light, Power and Gas Company for consent to increase its capital stock from $100,000 to $250,000 and to issue stock and bonds to the amount of $300,000, the state commission of gas and electricity denied the application.

SCRANTON, PA.—At a meeting of the Suburban Electric Light Company officers and directors were reelected. They are: president, A. L. Snowden; vice-president, G. M. Hallstead; secretary, treasurer and general manager, E. M. Stack. Besides the foregoing the directors are W. F. Hallstead, F. E. Platt, M. W. Colins, A. L. Francois, B. Morse and F. B. Ball.

BOSTON, MASS.—The Stanislaus Power Company, of Hartford, Ct., which was recently incorporated by Boston capitalists, has perfected its organization. John R. Rice, of Boston, has been elected president; Elijah H. George, of Boston, vice-president; Henry W. Palmer, of Boston, secretary, and Nathan Anthony, of Boston, treasurer. The concern has an authorized maximum capital stock of $10,000,000, and it is organized to develop an ambitious electric power enterprise in California.

MONTPELIER, VT.—At a special meeting of the board of directors of the Consolidated Lighting Company it was voted to make extensions to the system which will amount to about $100,000. The directors at the meeting were George G. Moore, A. D. Bennett and W. F. Davidson, of Port Huron, Mich.; J. E. Davidson, of Montpelier, and F. W. Morse, of Montpelier. The company will put in additional water-wheels in the Bolton falls plant, and will increase the capacity of that plant from 2,000 to 4,200 horse-power, which, with the 3,000 at the Pioneer plant, will give the company 7,200 horse-power.

ELECTRIC RAILWAYS.

CINCINNATI, OHIO—The Cincinnati, Milford & Loveland Traction Company will be extended to Columbus.

READING, PA.—The Boyertown & Palm Street Railway Company has commenced operations on the proposed new road from Boyertown to Swamp, in Montgomery county, a distance of six miles.

VICKSBURG, MICH.—The Vicksburg council has granted the Kalamazoo, Elkhart & South Bend Traction Railway Company a franchise to build and operate an electric railway on certain streets in the village.

FREDERICKTOWN, OHIO—Preliminary work on the Galion Southern Electric Railway is being pushed as rapidly as conditions will permit. The proposed line will run from Fredericktown to Galion, touching five villages en route.

DOYLESTOWN, PA.—The Doylestown town council has granted a franchise to the Perkasie, Doylestown & New Hope Street Railway Company. The latter will build a line between Perkasie and New Hope during the coming summer.

LIMA, OHIO—The Western Ohio Electric Railway has completed the thirty-two miles of new road between Findlay and Lima, Ohio, thus uniting the trolley systems of northwestern and southwestern Ohio, permitting through service from Cleveland to Cincinnati.

MENOMINEE, MICH.—Upper peninsula capitalists are organizing a corporation to build an interurban line to connect with Iron Mountain, Quinnesic, Norway, Vulcan, Loretto and Waucedah, Mich.; Commonwealth, Florence and other points in Wisconsin. The power will probably be generated at Twin falls, near Iron Mountain. The franchises are already secured. It is expected that, in time, this line will connect with the electric road now being built from Menominee to Escanaba, thus completing a circuit covering rich territory.

BOSTON, MASS.—The Boston Elevated Company will increase its rolling stock so as to have the additional equipment ready by summer, to the extent of forty-five elevated and thirty-seven surface cars. The elevated cars cost close to $10,000 each, making the total expense of the forty-five cars $450,000. The surface cars are slightly less expensive, costing about $7,000 each, so the new surface equipment will involve an expenditure of about $260,000, making the entire cost of new rolling stock about $700,000.

MIDDLEBROOK, VA.—The Virginia Valley Traction Company at its stockholders' annual meeting elected officers as follows: J. Frank Clemmer, president, Middlebrook, Va.; J. M. Smiley, first vice-president, Middlebrook, Va.; P. H. Hantsch, second vice-president, Philadelphia, Pa.; H. G. McGary, secretary and treasurer, Middlebrook, Va. The directors elected were: J. Frank Clemmer, Middlebrook, Va.; J. M. Smiley, Middlebrook, Va.; H. G. McGary, Middlebrook, Va.; W. W. Sproul, Middlebrook, Va.; W. L. Martin, Middlebrook, Va.; M. H. Bochaw, Philadelphia, Pa.; P. H. Hantsch, Philadelphia, Pa. The capital stock will be increased from $100,000 to $250,000. The stockholders intend to push the enterprise to completion, and construction will begin as soon as preliminary work is finished.

SHARON, PA.—The promoters of the trolley line between Conneaut Lake and New Castle, which was first projected by the Shenango Traction Company, composed of Greenville and Pittsburg men, have been granted charters for six trolley companies, for lines between Sharon and New Castle. The companies are: Shenango-Midland Street Railway Company, to build seven miles of road in the vicinity of Sharon; Northwest Middlesex Street Railway Company, to build four miles in the vicinity of Wheatland; Shenango Northern Street Railway Company, to build four miles of road in Hickory township, near Sharon; Central New Castle Street Railway Company, to build one mile of road in the city of New Castle; New Castle Northern Street Railway Company, to build three miles in the vicinity of Wheatland. The six companies are controlled by the same people. Edwin Ripley, of Sherman, N. Y., is president; and the directors are C. G. Glatzua, W. H. Waugh, Greenville; J. D. White, Rochester, and E. A. Henry, of Pittsburg. The combined capital is $120,000.

TELEPHONE AND TELEGRAPH.

LIVINGSTON, TEX.—The Livingston Telephone Company at its annual meeting reelected the board of directors for the ensuing year and declared a dividend of twenty per cent.

TAYLORSVILLE, MISS.—The directors of the Smith County Telephone Company have decided to build a line from Raleigh to Sylvarena, and another from Taylorsville to Laurel.

DOVER, DEL.—The Diamond State Telephone Company has decided to extend its lines from Kenton to Down's Chapel and thence to Hartley; also from Felton to Viola and Greenwood.

FLORENCE, COL.—The Colorado Telephone Company is contemplating a line from Florence into the Wetmore farming district and towns of Custer county. The new line will be about thirty miles long.

TERRE HAUTE, IND.—The Central Union Telephone Company and the telegraph companies have entered into an agreement for the joint use of the conduits which the telephone company is laying in the streets.

COLUMBUS, OHIO—The Central Union Bell Telephone Company has finished making the estimates for the new plant which will be installed in Columbus. The new exchange will accommodate the growth of the city until 1920.

ARCADE, N. Y.—A telephone system is being built from Chaffee and Sardinia by local capital. The villages which will be on the line are Arcade, Yorkshire, Delevan, Chaffee, Sardinia, Protective, Java, Java Village and Strykersville.

WALTHAM, MASS.—Work on the new telephone building at Waltham for the New England Telephone and Telegraph Company is rapidly advancing toward completion. The equipment will soon be installed and the building will be ready for occupancy in the early spring.

BERNVILLE, PA.—The Bernville Rural Telephone Company has elected the following officers; president, Willis L. Bright; secretary, Samuel T. Bordner; treasurer, Jacob M. Bordner; directors, Willis L. Bright, Jacob M. Bordner, John D. Snyder, Amos Berger, James D. Reeser, Charles C. Reeser.

DELMAR, DEL.—The Diamond State Telephone Company and the Riverton-Delmar Company have entered into an agreement by which the two companies will act jointly. The Diamond State Company will control the Delaware exchange. There will be about one hundred telephones on the country line.

WEST LIMA, OHIO—The Beaver Telephone Company has elected the following officers for the ensuing year: trustees, W. H. Ruhlman, P. W. Sprinkle, N. Wisler, S. J. Heck, E. L. Lonecker, J. Harold, Theodore Obenauf, Robert Hunter and Allen Felger; treasurer, John Yoder; president, W. H. Ruhlman.

TRENTON, N. J.—At the annual meeting of the Interstate Telephone Company the old officers and directors were reelected. They are H. R. Swartz, president; William S. Hancock, first vice-president; C. W. Kline, second vice-president; Barker Gummere, Jr., treasurer; F. A. Demarest, general superintendent and secretary.

WILKESBARRE, PA.—The Delaware & Atlantic Telephone and Telegraph Company during the past year added 1,576 new telephones to its system in the district composed of Chester and a portion of Delaware counties. The number has nearly been doubled in the past eighteen months and many new lines are now under construction.

ALBANY, ORE.—A new telephone line from the central part of eastern Oregon is to be built early in the spring to connect with the Willamette Valley system of the Pacific States Company at Albany. The line will be built from Prineville directly west to the Cascade mountains, crossing over the mountains to Cascadia, where it will connect with the line now running to that point from Albany.

WILKESBARRE, PA.—At the annual meeting of the Farmers' Telephone and Supply Company the stockholders elected the following directors: C. F. McHugh, B. F. Croop, I. A. Long, Dr. C. A. Long, S. M. Whitesell, E. B. Koons, G. R. Shaw, M. W. Brittain and C. B. Wheeler. The officers for the year are Dr. C. A. Long, president; J. E. Snyder, vice-president; C. B. Wheeler, secretary, and M. A. Benscoter, treasurer. G. R. Shaw was elected manager

DES MOINES, IOWA—At the annual meeting of the Western Electric Telephone Company, held in Des Moines, the expenditure of some $200,000 in improvements during the coming year was authorized. This will be used in developing lines in the northwestern part of the state. The company took over one of the Dakota rural lines in July of last year. The plans for the coming year contemplate one of the most extensive rural systems in the state.

PULASKI, N. Y.—The Black River Independent Telephone Company, which has an exchange in Pulaski and works in conjunction with the Ontario Telephone Company, of Oswego, has completed a line from Altmar to Williamstown and also to Redfield. With the completion of the new lines the Black River Company now has direct connection with Camden through the Home Telephone Company of the latter place. Toll stations have been established at Altmar, Williamstown and Redfield.

COLFAX, LA.—The Cumberland Telephone and Telegraph Company has bought the Colfax Telephone Company, operating at Colfax and at Boyce, and the Colfax town council has granted the Cumberland the right to string wires through the town. The company has poles erected along the right of way of the Louisiana Railway and Navigation Company from Alexandria to Shreveport, and it is the purpose to complete the line immediately to Shreveport. The system heretofore in use by the Colfax Telephone Company will be remodeled and metallic wires put in, giving better long-distance connection.

NEW ORLEANS, LA.—Before the end of this year Algiers and neighboring suburbs will be provided with a telephone exchange. The Cumberland Telephone and Telegraph Company has decided to erect a branch exchange upon a site recently purchased. The exchange will be a two-story brick building, with ornamental trimmings. It will contain all necessary conveniences for the employés of the company and ample space for installing the apparatus. Arrangements will be made for a service of 3,000 telephones, but the switchboards ordered by the company are so constructed that they may be enlarged to a capacity of 9,600.

HAMMONDSPORT, N. Y.—At the annual meeting of the Bath & Hammondsport Telephone Company the following officers and directors were elected: J. W. Brundage, president; W. H. Dildine, vice-president; Clark H. Bronson, secretary; James H. Snellie, treasurer; directors, J. W. Brundage, W. H. Dildine, Clark H. Bronson, L. H. Gardner, W. A. Kniffin, I. H. Bronson, J. H. Snellie. Last November this company bought out the Niver line, running to North Urbana and Wayne, and now controls lines between Bath and Hammondsport, Wheeler and Hammondsport and Hammondsport over Mount Washington to Bath, a total length of thirty-five miles. This company is in connection with the Century company at Bath and will be operated in connection therewith.

ALLENTOWN, PA.—At the annual meeting the Consolidated Telephone Companies, of Pennsylvania, elected these directors: Robert E. Wright, Wilson J. Hartzell, George O. Albright, Thomas Daugherty, Allentown; Isaac Hiester, A. J. Brumbach, Reading; Frank M. Green, Washington, D. C.; J. P. Helfenstein, Shamokin; George R. Bedford, W. H. Lathrop, George N. Reichard, I. A. Stearns, Wilkesbarre; C. W. Kline, Alvan Markle, Hazleton; C. D. Simpson, Scranton; A. P. Trautwein, Carbondale. The directors elected these officers: president, Robert E. Wright; vice-president, C. W. Kline; secretary and treasurer, C. M. W. Keck; general superintendent, Charles West. The company owns the independent systems at Scranton, Carbondale, Wilkesbarre, Hazleton, Allentown, Reading, Slatington, Lehighton, Mauch Chunk and many smaller towns in eastern Pennsylvania.

LEGAL NOTE.

THE RECOVERY OF DAMAGES FOR PROPERTY MUTILATION—The right to recover punitive damages for the cutting of trees upon a sidewalk for the accommodation of electric light wires, in entire disregard of the rights of the abutting owner and against his protest, is sustained in Brown *vs.* Asheville Electric Company (N. C.), 69 L. R. A. 631.

PERSONAL MENTION.

MR. FRANK CAUM, of Hartford, Ct., general manager of the Hartford Consolidated Street Railway Company, has been appointed to succeed Mr. Frank Silliman, Jr., as manager of the Scranton (Pa.) Railway Company.

MR. E. H. VALENTINE, president of the Valentine-Clark Company, Chicago, Ill., has disposed of his interests in the company to Mr. E. L. Clark, formerly secretary and treasurer, and who now succeeds Mr. Valentine as president.

MR. K. CONWAY, Athens, Ga., has assumed the management of the Southern Bell Telephone Company's office at Anniston, succeeding Mr. John L. Brown, who has been promoted to a position in the toll traffic department, with headquarters at Atlanta, Ga.

MR. H. C. MACKAY, who has been controlling auditor of the Milwaukee Electric Railway and Light Company for over eight years, has resigned and will go to Norfolk, Va., to take the position of comptroller of the Virginia & Carolina Coast Railroad Company.

PROFESSOR W. D. TAYLOR, professor of railway engineering at the University of Wisconsin, has tendered his resignation, to take effect at the end of this semester. Professor Taylor has been appointed chief engineer of the Chicago & Alton Railway. Professor D. W. Mead, of the department of hydraulic and sanitary engineering, will take charge of some of Professor Taylor's work until a successor is chosen.

MR. J. M. WALKER, chief engineer of the Pennsylvania & Mahoning Valley Railway Company, has accepted a similar position with a new railway company which will build a line into Lima, Ohio. Mr. Walker had been associated with the Mahoning Valley company for about ten years. Prior to the merger of the Mahoning Valley and the Youngstown & Sharon lines Mr. Walker was superintendent of the Mahoning Valley system.

MR. WILBUR H. TRAVER, formerly connected with the Rand Drill Company for a period of twelve years as manager of the Chicago territory until the consolidation of the Ingersoll-Rand companies, after which he was manager of the railroad department, with headquarters in Chicago, has severed his connection with this company and accepted services with the Chicago Pneumatic Tool Company, as manager of the mining and contract department. Mr. Traver will devote his time principally to the sale of air-compressors, rock drills and mining machinery.

EDUCATIONAL.

UNIVERSITY OF ILLINOIS—The annual inspection trip of the senior class in electrical engineering at the University of Illinois was made under the direction of Professors Morgan Brooks and Gardner during the week beginning January 22. This trip included visits to Pontiac, Moline and Chicago, at which cities various electrical installations of interest were inspected.

COLLEGE OF ENGINEERING, UNIVERSITY OF WISCONSIN—The College of Engineering, University of Wisconsin, Madison, Wis., has announced a complete list of non-resident lecturers who will address the students in engineering at the university during the present year. F. B. Wheeler, engineer of the Semet-Solvay Company, Syracuse, N. Y., will deliver two lectures on "Gas Engineering"; G. M. Davidson, chemist for the Chicago & Northwestern Railway, "Purification of Water for Locomotive Boilers"; J. M. Faithorn, president of the Chicago Terminal Transfer Company, "Regulation of Railroad Freight Rates"; B. A. Behrend, chief engineer of the Bullock Electric Manufacturing Company, "High Speed in Modern Engineering"; S. Wyer, consulting engineer, Columbus, Ohio, two lectures on "Gas Producers and Producer Gas"; L. R. Clauson, University of Wisconsin '97, signal engineer of the Chicago, Milwaukee & St. Paul Railway, "Railroad Signaling"; Ralph Mojeski, consulting bridge engineer, Chicago, "The New Thebes Bridge Over the Mississippi near St. Louis"; Arthur D. Wheeler, president of the Chicago Telephone Company, subject to be announced later; Professor L. P. Breckenridge, College of Engineering, University of Illinois, "The Use of Bituminous Coal in Boiler Furnaces"; Andrews Allen, University of Wisconsin '91, construction engineer, Chicago, "Engineering Construction." Frank W. Skinner, New York city, has been appointed special lecturer in field engineering for the second semester in the present academic year.

ELECTRICAL SECURITIES.

The sentiment that the prolonged bull campaign, with its continued upward tendency, would in a short time experience a check, has, if anything, gained strength within the past week. A considerable reduction in general commission house buying, and the decided tendency to profit-taking, together with considerable fluctuation in prices, have had the effect of lessening speculation. There has been no material change in the financial situation. While there was a small flurry in call rates, five per cent has ruled generally as the maximum. The prospect of a New York state legislative investigation of the banking department is contended to be a cloud on the financial horizon, and until this matter is thoroughly settled there will be, from time to time, uncertainties developed which will take strength away from the market security. The report of the United States Steel Corporation for the December quarter is a striking indication of the general industrial prosperity. This showed, in addition to decided net gains, the largest total of unfilled orders on hand, amounting to 7,605,086 tons, against the previous quarter's total of 5,865,877 tons. The prospect of a coal strike, involving both the hard and soft coal miners, is now looming up very strongly, and unless there is a decided change of front within the next week, it is possible that within a month coal rates will have been advanced, and the public again be experiencing the difficulties from which it has hardly recovered.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 3.

New York:	*Closing.*
Brooklyn Rapid Transit	86⅜
Consolidated Gas	180
General Electric	175¼
Interborough Rapid Transit	233
Kings County Electric (ex rights)	175
Manhattan Elevated	160
Metropolitan Street Railway	120¾
New York & New Jersey Telephone	155
Westinghouse Manufacturing Company	189

It is stated that the orders booked in the railway department by the Westinghouse Electric and Manufacturing Company for the month of January amounted to $2,000,000, the largest for any month in its history. Semi-official estimates place the probable total business for 1906 at $40,000,000.

Boston:	*Closing.*
American Telephone and Telegraph	139
Edison Electric Illuminating	248
Massachusetts Electric	66
New England Telephone	136¾
Western Telephone and Telegraph preferred	92½

The Boston Elevated Railway Company has declared the regular semi-annual dividend of 3 per cent, payable February 15.

The Massachusetts Electric Companies' statement for the quarter ended December 31, 1905, is as follows: gross, $1,628,993; expenses, $1,157,365; net, $471,528; charges, taxes, etc., $385,229: surplus, $86,299, as compared with $42,509 for the same quarter of 1904.

Philadelphia:	*Closing.*
Electric Company of America	12
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	7¾
Philadelphia Rapid Transit	32½
United Gas Improvement	99

It is stated that 1905 has proven the best year in the history of the United Gas Improvement Company. Net earnings, it is expected, will show largely in excess of $5,000,000, and nearly 15 per cent on the $36,725,000 stock.

Philadelphia Rapid Transit gross earnings for January increased about $150,000 over the same month a year ago. The increase for the seven months ended January 31, 1906, is over $700,000, an average of $100,000 per month.

Chicago:	*Closing.*
Chicago Telephone	138
Chicago Edison Light	161⅜
Metropolitan Elevated preferred	69
National Carbon common	82½
National Carbon preferred	116
Union Traction common	10
Union Traction preferred	40

The January average of Oak Park Elevated traffic was 47,921, an increase of 3,253.

South Side Elevated January daily passenger average was 92,406, an increase of 7,837.

INDUSTRIAL ITEMS.

PASS & SEYMOUR, INCORPORATED, Solvay, N. Y., has issued two bulletins giving prices of electrical specialties. Catalogue No. 16 is illustrated and gives a brief description of the "P. & S." specialties. Price list No. 83 gives the code word, trade number and price per 100 of the various articles.

GEORGE A. HEBB, 68-70 William street, Newark, N. J., manufacturer of machinery, railway and agricultural springs of every description, is mailing a sample spring to some of its patrons. The novel manner in which this publicity is being carried out will, no doubt, be of considerable benefit to the manufacturer.

EVANS, ALMIRALL & COMPANY, New York city, announce the appointment of Benjamin Kauffman as western manager. Mr. Kauffman has for the past year been assistant western manager. Cuthbert Schaefer has been appointed assistant western manager. The Chicago offices are at 1057-1058 Monadnock Building.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., announces the appointment of Frank N. Jewett as district manager for the states of Minnesota, Wisconsin, eastern Iowa, northern Illinois and Indiana, and northern and western Michigan, with offices at 1623-1624 Marquette Building, Chicago, Ill.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has published in bulletin No. 11 some excellent literature descriptive of Jeffrey mining machinery. The bulletin contains, in addition to many excellently worked half-tones illustrating special machines and typical applications, an article entitled "The Application of Electricty to Mining," by F. L. Sessions.

THE WIRE AND TELEPHONE COMPANY OF AMERICA, Rome, N. Y., in bulletin No. 100 reproduces in half-tone a very excellent view of its new factories. The company announces its acquiring of the Electric Wire Works and the Empire Wire Company, both of Rome. A very interesting sketch is given of the material the company is manufacturing, and an idea of the capacity of its contracting and engineering departments.

THE A. D. GRANGER COMPANY, New York city, has published a handsome booklet descriptive of the work entailed in the erection of complete power plants, including steam and electrical transmission for industrial and manufacturing projects, hotels, office buildings, apartment houses, central stations and isolated lighting and power installations. The company has offices also in the Commonwealth Building, Philadelphia, Pa., and in the Bessemer Building, Pittsburg, Pa.

THE SPRAGUE ELECTRIC COMPANY, New York city, is making a specialty of motor equipments for driving, heating and ventilating apparatus. Among recent orders for such equipments are the following: the First Day and Night Bank, Fifth avenue and Forty-fourth street; Knickerbocker Hotel, Broad Exchange Building, and the new Women's Hospital. All of these are in New York city. In Hoboken, N. J., the company has put in an equipment at the Hoboken terminal of the Delaware, Lackawanna & Western Railroad.

THE ELMER P. MORRIS COMPANY, 51 Dey street, New York city, announces that its output in wooden pins is now 25,000 per day. The company is installing machinery which will double this capacity. This company makes pins only from birch wood, sizes one and one-quarter by eight inches, one and one-quarter by nine inches, one and one-half by nine inches. The mill is located at West Seebois, Me. The company carries in stock at all times 100,000 pins. A large stock is also carried of Miller anchors and malleable iron pins and brackets, wood and malleable cross-arms, cross-arm braces, bolts, lage and washers.

THE VALENTINE-CLARK COMPANY, Chicago, Ill., dealer in cedar poles and fence posts, announces the retirement of Mr. E. H. Valentine, president of the company, who has disposed of his interests to Mr. E. L. Clark, formerly secretary and treasurer, and who now becomes president. The corporate name of the company will continue as heretofore. Mr. Clark has been identified with the company since its formation, and enjoys an extensive acquaintance. He possesses an intimate knowledge of the trade in all its details. The company has long occupied a prominent position in the cedar industry, enjoying an extensive volume of business in all lines of electric construction requiring the use of poles for power transmission.

M. W. DUNTON & COMPANY, 65 Atlantic avenue, Providence, R. I., manufacturers of "Nokorode," have recently devised an enameled box for their soldering paste. This box is enameled in black and white, and makes a very pleasing appearance. The company is offering free a valuable pocket gasoline torch for the return of fifty covers from the two-ounce boxes. The company reports that the wooden cases used in shipping "Nokorode" are a great convenience to the jobber in handling, as they do not have to be packed and repacked when shipping. These cases also make a very neat appearance on the store shelves.

THE LUDLOW VALVE MANUFACTURING COMPANY, Troy, N. Y., announces the consolidation of the Sturgess Governor Engineering Company with the Ludlow Valve Manufacturing Company, with the object of improving the manufacturing facilities of the former company for introducing more extensively its well-known specialties. The Ludlow Valve Manufacturing Company will make these specialties in a portion of the recently built additions to its plant specially set apart for the purpose. The Sturgess engineering department of the Ludlow Valve Manufacturing Company will shortly place upon the market a new vertical water-wheel governor which will supersede the older forms and contain a number of features which the company anticipates will instantly appeal to users of water-wheel governors.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

LOS ANGELES, CAL.—The Electrical Construction Company has been incorporated with a capital stock of $30,000. The directors are L. R. Saunders, M. K. Baugh and E. Locke, all of Los Angeles.

LINCOLN, NEB.—The Wolfe-Lovett Electrical Company, of Omaha, has filed articles of incorporation with the secretary of state. The concern has a capital stock of $25,000 and a paid-up capital of $15,000. It will engage in the manufacture of electrical supplies. The incorporators are L. C. W. Wolfe, L. C. Wolfe, Israel Lovett and E. R. Lovett.

ROCHESTER, N. Y.—The incorporation papers of the American Automatic Telephone Company, capitalized at $1,500,000, with headquarters in Rochester, have been filed in Albany. The company will manufacture an automatic switchboard apparatus, invented by J. W. Lattig, of Rochester, and Charles Lane Goodrum, of Athens, Ga. The directors are B. J. Williams, Shelby, Ohio; J. W. Lattig, State Senator John Raines, Canandaigua; Alvaro L. Thompson, Henry H. Stebbins, Jr., Joseph R. Webster and George R. Raines.

HARTFORD, CT.—Papers for the incorporation and organization of the Hartford Light and Equipment Company have been approved by the secretary of state. The company is formed for the purpose of "leasing and renting prismatic hoods for intensifying and transferring electric light." The authorized capital stock is $75,000, and the company begins business with $6,000. The incorporators are Henry Schoenfield, of Congres, N. Y.; Joseph R. Carroll, of East Hartford, and William S. Davis, of Hartford. The Prismatic Hood Company, of New York city, holds all the common stock.

NEW PUBLICATIONS.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The bulletin of the Massachusetts Institute of Technology for January contains the report of president Henry S. Pritchett, and the reports to the president of the various departments. The report of the registrar shows that for the year 1905-1906, 1,466 students have registered at the institute.

THE ONTARIO POWER COMPANY—The Ontario Power Company has reprinted the paper presented by Mr. P. N. Nunn at the Asheville (N. C.) meeting of the American Institute of Electrical Engineers. This paper describes in detail the development of the Ontario Power Company and the construction of the large hydroelectric plant situated in the gorge below the falls. The company has also issued a handsome lithograph giving a bird's-eye view of the hydroelectric developments on the Canadian side of the Niagara river and a map showing the lands owned by the Ontario Power Company and allied companies.